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ABSTRACT

This examination of the process the Toronto elementary school system is using to become familiar with microcomputers focuses on the introduction of microcomputers into the school setting and the resulting changing responses and interactions among pupils, teachers, administrators, parents, and others. In Phase 1, principals were surveyed for background information, while Phase 2 involved observation, interviews, and surveys in schools and special education settings in the Toronto elementary school system during the 1982-83 school year. The analysis of the data obtained is based on the concept of preparedness context, which refers to people in educational settings and their preparation for new technology. The first section of this report describes and discusses the results of the survey conducted in Phase 1. Results of the Phase 2 fieldwork are then organized around a specific preparedness context: grassroots preparedness, uneven preparedness, unallied external preparedness, and experimental preparedness. Typical patterns of interaction are traced and linked with preparedness through a description of each awareness context, an examination of the structural conditions that enter into the context, and examination of the consequent interactions, tactics, problems, and solutions. Appendices describe data collection methods and include the collection instruments used. (LMM)

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Contents

Preface 1

Part One: The Survey 5
    Results 5
    Discussion 14

Part Two: The Fieldwork 16

Introduction 16
    Grass-Roots Preparedness for Microcomputers 17
        Contributing Structural Conditions 18
            Emotionally prepared pupils. 18
            Intellectually prepared pupils. 19
            Emotionally prepared staff members. . . . 20
            Intellectually prepared staff members. . 21
            Emotionally prepared parents. 21
            Intellectually prepared parents. 22
            Unprepared principals. 22
            Insufficient staff training. 23
            Limited policy development. 23
            Limited funding. 25
            Limited information and support. 26
            Limited software. 28
        Consequences of Grass-Roots Preparedness . . . 30
            School staff are making varied efforts to learn about microcomputers. 30
            Teachers are creating software. 31
            School staff want more hardware. 34
            Varied strategies are used to obtain more hardware. 35
            Special schedules are devised. 35
            Pupils interact and socialize. 38
            Pupils are providing input and expertise. 41
            Different teacher-pupil roles are developing. 42
            Parents are providing input and expertise. 45
            School staff want more information and support. 46
    Uneven Preparedness for Microcomputers 48
        Contributing Structural Conditions 48
            Uneven preparedness of school staff. . . 48
            Uneven pupil preparedness. 51
            Uneven parent preparedness. 53
            Slow, uneven policy formulation. 54
        Consequences of Uneven Preparedness 55
            Controversy over priorities. 55
            Controversy over goals and purposes. . . 58
            Controversy over methods. 60
            Controversy over age. 60
            Controversy over type of pupil. 62
            Controversy over teacher training and involvement. 63

Changing roles and responsibilities of school staff. 65
Poor teacher-parent communication. . . . 69
Unallied External Preparedness for Microcomputers . 70
Contributing Structural Conditions 70
Industrial preparedness -- hardware. . . 70
Industrial unpreparedness -- educational software. 71
Educators' unpreparedness -- software. . 71
Consequences of Unallied External Preparedness 71
Software is obtained from many sources. . 71
Controversy over games. 72
The popularity of open-ended programs. . 74
Government initiatives. 75
Experimental Preparedness for Microcomputers . . . 77
Contributing Structural Conditions 78
Willingness to experiment. 78
Consequences of Experimental Preparedness . . 80
Commodore products well accepted. 80
Numerous benefits and uses reported. . . 81
Various methods used experimentally. . . 94
Various locations used experimentally. . 97

Postscript 100

References 102
Software 103

Appendix A: Methods Used in Part 2 105
Guidelines for Observers 106
Sampling of Schools 106
Arrangement of Visits to Schools 107
Other Interviews 107
Survey of Parents 107
Coding and Sorting 108

Appendix B: Survey Questionnaire Used in Part 1 109

Appendix C: Three Samples of Writing Done by Elementary Pupils With "Story Writer" 117

Appendix D: Excerpt From the Report Written by Sandra Browne Entitled "Toronto Board of Education LOGO Field Study Report" 124

Appendix E: Parent Letter and Consent Form 137

Appendix F: Parent Questionnaire 140

Preface

The computer age has begun, and many aspects of society are changing as a result. For example, we are at present seeing a rapid proliferation of microcomputers at all levels of the educational system. Indeed, a recent memorandum of the Ontario Ministry of Education contained the following statement on the future use of computers in the Ontario education system:

> For the next few years, there will be a growing use of computers in classrooms and schools. The machines will be used by pupils for direct learning and for administrative purposes.
>
> Classrooms will have increasing numbers of "stand-alone" microcomputers. Pupils will use these machines to do a variety of activities - analyses and reasoning exercises; simulation in subjects such as science, business studies, history, geography; word processing in English, French, business studies, and other subjects; graphics in technical studies, art and most other subjects; music training; record keeping; etc.
>
> Policy/Program Memorandum No. 31 (February 23, 1982), p.#1

However, there are many ways in which computers may be affecting education, and educators are now having to make many decisions with respect to the use of computers in the clasroom before all the evidence related to these effects is in.

The purpose of this study is to contribute to an understanding of the impact that computers are having on education in order to explain, predict, and control this impact. The specific example that is examined here is the Toronto elementary school system and the process it is using to become familiar with microcomputers. The focus is not on computer hardware and software or on individual schools, classrooms, teachers, pupils, or other persons. Rather, it is on what happens when microcomputers are introduced to a school setting within certain contexts of action and on the resulting changes, responses, and interactions among pupils, teachers, administrators, parents, and other persons.

The approach reflects a certain sociological perspective that is not at all technical in nature. If, increasingly, microcomputers are finding their way into the schools, then what are the psychological and social effects, both positive and negative, that children might experience as a result of having the machines in their classrooms? Do computers in the classrooms change teacher-pupil and pupil-pupil relationships? Do children personify computers and as a result develop a new form of pupil-computer relationship and new personality types capable of spending long hours with computers? Do computers in the classrooms change, for better or worse, children's self-images, aspirations, desire to compete with their peers, ability to concentrate, motivation to learn, attitudes, or behaviours? Do children experience new forms of stress, exhaustion, fear, excitement, involvement, or rewards? Are there other side effects not yet imagined or intended? Do computers extend the ability of children to learn, think logically, and solve problems, or do they inhibit or disturb the natural stages of cognitive development? Do computers change the structure of knowledge or the relationships among the disciplines? Do they change the form of classroom learning? Are teachers using computers primarily for drill, remedial, and/or review work, or are they using them mainly to challenge the bright pupils? Are computers being used to teach computer programming or to teach an entire course in another subject area such as history? Are teachers using them for diagnostic and/or testing purposes? Are special education teachers making computers an important part of their teaching? Are regular teachers integrating them into the entire curriculum? Are the roles of, and relationships among, school staff members different as a result of the introduction of computers? In what ways are parents involved with microcomputers in the schools? Are parent-teacher relationships altered?

To answer these kinds of questions, we did intensive fieldwork, involving a combination of questionnaires, observation, and interviews in the Toronto elementary school system during the 1982-83 school year. (A full description of the methods used is provided in appendix A.) The work was organized into two distinct and very different phases. Phase 1 consisted of a survey questionnaire (see appendix B) completed by nearly every elementary school principal. This provided background information on such matters as the numbers and kinds of computers and peripherals in each school; numbers and types of teachers involved with computers; numbers, types, and ages of the children involved; methods of accessing computers; length of time the schools have been involved; and subject areas and ways in which computers are being used. This background information was used to characterize the context within which the findings of the study have been formulated and as the basis for a plan for the fieldwork of phase 2. Phase 2 consisted of observing, talking, listening, interviewing, surveying, and collecting anecdotes in approximately three-quarters of the Toronto elementary schools as well as in various special education settings in Metropolitan Toronto. The schools and locations were chosen to give us maximum exposure to different aspects of microcomputers in education - at every grade level, in numerous kinds of special education settings, with teachers and administrators having varying degrees of involvement and interest, in schools having different numbers of computers, in schools having machines in different locations, in schools in areas of Toronto with different socio-economic backgrounds, and so on. In some schools the researchers moved about quite freely, recording information in every way possible; in other schools they conducted their activities according to schedules set up by the school principal. In some schools the research activities took a couple of hours; in other schools they lasted for three or four days. Some parents were interviewed, and some filled out questionnaires. Several key administrative personnel and persons highly knowledgeable in the field were also contacted.

In presenting what we have found through the methods used in phase 2, we have chosen to write a report that is abstract, explanatory, and theoretical in nature rather than one that is comparative. Our analysis is based on what we term preparedness context, which is more fully discussed in part 2. This term refers to the people in the educational setting who are prepared, and the ways in which they are prepared, for a new technology. It makes a great deal of difference who is prepared - emotionally and/or intellectually - and to what degree, and by using this concept or scheme we have been able to explain and organize many diverse, complex, and paradoxical events. The scheme allows us to claim that discernible patterns of change, response, and interaction occur predictably during the process of introducing microcomputers to an educational setting and that knowledge of these patterns helps persons in the system make decisions and contend with events.

The authors are indebted to a great many people. They wish especially to thank Richard Lee, co-ordinator of the Department of Computer Studies and Applications of the Toronto Board of Education (TBE) for his continual and invaluable support and consultation.

The survey questionnaire for phase 1 of the study was polished and finalized with the help of Ronald Auckland, principal of Island Public School; Gary Fairfoul, vice-principal of Alexander Muir/Gladstone Avenue Junior and Senior School; Philip Hornick, principal of Indian Road Crescent Junior Public School; and Dr. Rudolph Wagner, vice-principal at Earl Grey Senior Public School.

Sandra Browne of A & S Financial Consultants Limited, while not an author, was involved as a consultant in the introduction of LOGO to a Grade 5-6 classroom taught by Bernice Laski at Maurice Cody School. She documented their experiences, and many of her ideas have been incorporated into this report.

We are especially indebted to all the principals, vice-principals, teachers, and other staff members of the schools who contributed their time for interviews and allowed us access to their classrooms and staffrooms. Their response to this project was particularly gratifying -- the response rate to the phase 1 survey questionnaire was close to 100 per cent, and we were allowed access to three-quarters of the schools for phase 2, often on very short notice. We also wish to acknowledge the co-operation of the Special Education Department, in particular, the Metropolitan Toronto School for the Deaf, Sunny View School, Bloorview School, the Clarke Institute of Psychiatry, the Hospital for Sick Children, Valta Day Centre, Youthdale Treatment Centre, Delisle House, Toronto General Hospital, and Lyndhurst Hospital, as well as the co-operation of the Teaching Aids Department.

Many pupils in the schools talked to us, and several parents agreed to be interviewed or to fill out questionnaires. We appreciate their contributions as well.

Rosemary DaSilva of the School Community Relations Department of the TBE made arrangements to have questionnaires translated and to have interpreters present during home interviews. We wish to thank her, as well as the translators and interpreters.

Richard O'Shea of the Library Services Department is to be thanked for conducting a search of the literature on the topic of microcomputers in elementary education.

Various persons from the Faculty of Education of the University of Toronto, George Brown College of Applied Arts and Technology, and the Toronto Teachers' Federation were interviewed and contributed valuable and different perspectives. We appreciate the willingness with which they contributed their time. A couple of outside persons considered to be experts in the field of microcomputers also provided thoughtful comments.

Finally, we wish to express our gratitude to Deborah McFarlen, who typed and helped edit several drafts and the final version of the questionnaires and this report.

Part One: The Survey

Questionnaires were distributed to 118 elementary schools on September 27, 1982. Ninety-one schools returned their questionnaires within two weeks. After a telephone follow-up, another 13 schools returned their questionnaires. Eleven more schools returned questionnaires after a subsequent follow-up by mail. Thus questionnaires were received from 115 schools altogether, for a response rate of 97 per cent.

Results

The significance criterion for all statistical tests mentioned in this section was a chance probability less than 0.05.

Only 3 of the 115 schools reported that they had no microcomputers.* All but one school reported the total number of microcomputers that they had. Altogether they reported 308 machines. This figure does not include microcomputers used in the travelling laboratories or in the hospitals and institutions program.

The numbers of schools reporting various numbers of microcomputers is shown in table 1. More than half of the schools reported only one or two. As is indicated in table 2, most schools obtained their first microcomputers quite recently, almost three-quarters of them in 1981 or 1982.

Almost all the microcomputers whose make was reported were Commodore products. By far the most popular model was the 4032. Of 297 machines whose manufacturer was reported, 295 were made by Commodore (the other two were manufactured by Apple). The model number was reported for 290 of the Commodore machines, and 264 were 4032s.

An analysis of variance failed to detect any difference from one administrative area to another in the mean number of microcomputers at a school. The means ranged from 2.4 in Area West to 2.8 in Area Central.

Ninety-two schools reported both the number of microcomputers that they had and the number of these computers that had been bought from board funds other than through the central budget for computer literacy or the furniture and equipment budget. These schools reported 258 microcomputers altogether, of which 68 (26 per cent) had been bought from other board funds. One hundred and ten schools reported both the number of microcomputers that they had and the number of these computers that had been bought from funds other than board funds (for example, funds

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*At least one of these schools obtained a microcomputer later in the school year. Two schools were alternative schools with relatively few pupils.

Table 1

Numbers of Schools Reporting Various Numbers of Microcomputers (Fall 1982)

Number of Microcomputers	Number of Schools
0	3
1	34
2	29
3	21
4	13
5	6
6	1
7	4
9	1
14	2
Not given	1
Total	115

Table 2

Years in Which Schools Obtained Their First Microcomputers

Year	Number of Schools
1977	1
1978	2
1979	4
1980	22
1981	71
1982	11
Not given	4
Total	115

provided by home and school associations). These schools reported 307 microcomputers, of which 64 (21 per cent) had been bought from funds other than board funds.

The most frequently reported type of peripheral equipment was the cassette recorder, reported at 106 of 108 schools providing information. The only other types of peripheral equipment reported by more than 7 schools were the printer, reported by 25 schools, and the disk drive, reported by 23. Eighteen schools reported using both disk drives and printers.

Median tests revealed that the use of disk drives and printers was related to the year in which a school had received its first microcomputer. Of twenty-nine schools that had received their first microcomputers before 1981, thirteen (45 per cent) reported that they were using disk drives while only ten (12 per cent) of eighty-two less experienced schools reported that they were using them.* Similarly, printers were reported in use at twelve (41 per cent) of twenty-nine more experienced schools and at thirteen (16 per cent) less experienced schools.

Few schools reported that peripheral equipment had been lent to or given them by teachers or parents. Four schools reported that teachers had lent peripherals, and two that parents had. One school reported that a teacher had given it peripheral equipment, and five that parents had.

The numbers of microcomputers kept in various places are shown in table 3. The total number of microcomputers in this table is greater than 308, because a single microcomputer could be reported in more than one category. It should also be noted that the category "rotating between classes" did not appear on the questionnaire but was reported in the "other" category by several respondents.

The replies of the schools to questions on whether they would be using microcomputers in special education, remedial instruction, or enrichment/advancement during the current school year are indicated in table 4. Chi-square tests revealed that schools were more likely to report that they would be using microcomputers for enrichment/advancement than they were to report that they would be using them for either of the other two purposes. However, 74 per cent or more of all schools reported that they would be using microcomputers for each of these purposes.

The percentages of schools having microcomputers that reported various descriptions of their pupils' and teachers' use of microcomputers are given in table 5. Chi-square tests revealed that schools were more likely to report that some teachers would be using microcomputers occasionally than that some pupils would be. Schools were also more

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*The number of schools does not add to 115, because 4 schools failed to answer both questions.

Table 3

Number of Computers Kept in Various Places

Place	Number of Microcomputers*	Per Cent of Total
In one classroom	101	33
In a central place, from which they are taken to classrooms when needed	60	19
In the computer room or lab	41	13
Rotating between classes	35	11
In the library	28	9
In the resource centre	27	9
In the office	2	1
Other	27	9

*Microcomputers could be reported in more than one category.

Table 4

Schools' Replies To Questions About the Use of Microcomputers in Special Education, Remedial Instruction, and Enrichment/Advancement (N = 115)

Question	Yes	No	Don't Know	No Answer
Do you expect microcomputers to be used in special education at your school this year (1982-83)?	85	16	11	3
Do you expect microcomputers to be used in remedial instruction at your school this year (1982-83)?	96	7	9	3
Do you expect microcomputers to be used for enrichment/ advancement at your school this year (1982-83)?	108	1	2	4

Table 5

Numbers of Schools Reporting Various Descriptions of the Expected Use of Microcomputers by Students and Teachers

Description	Students	Teachers
Some will use occasionally	15	34*
Some will use regularly	64	74
Most will use occasionally	52	30*
Most will use regularly	19	5*

*Significant difference (p <0.05) between reports for students and teachers.

likely to report that most pupils would be using microcomputers occasionally or regularly than they were to report that most teachers would be.

Forty-eight of 111 schools that compared their use of microcomputers in 1981-82 to the use they expected to make of them in 1982-83 reported that their use of microcomputers would be much greater in 1982-83. A further 56 reported that their use would be somewhat greater; none reported that it would be less. A median test showed that schools that had obtained their first microcomputers before 1981 were no less likely than schools that had obtained theirs more recently to report that their use of microcomputers would be much greater in 1982-83. Median tests also failed to detect any differences between these two groups of schools in the likelihood of their reporting that during 1982-83 they would have a computer club, a computer corner in the library, or informal meetings about computers. Forty-two schools reported that they would have a computer club this year, 84 that there would be informal meetings, and 44 that there would be a computer corner in the library.

The number of teachers, principals, and vice-principals reported as using microcomputers at each school varied from 1 to 19, with a mean of 4.7 and a median of 4. According to the 1982-83 TBE yearbook, the number of teachers, principals and vice-principals at the schools responding to the survey ranged from 1 to 51, with a mean of 20.7 and a median of 21. The numbers and percentages of schools reporting that at least one teacher using microcomputers was teaching each of the grades from Kindergarten to Grade 8 are shown in table 6. The replies from junior and senior schools revealed that in these schools the number of teachers reported for each grade was positively correlated with grade.

Open-ended questions asked for descriptions of the uses to which computers were put and for definitions of computer literacy and computer awareness. Categories for coding were derived from an examination of the questions, and three judges coded the questions independently. The answers could be coded in more than one category. The reliability of the mean of their estimates of the frequency of each coding category was assessed with the Spearman-Brown prediction formula (Winer 1962). The reliability coefficients for the eight categories of computer use ranged from 0.72 to 0.96. The coefficients for the four categories of computer awareness ranged from 0.86 to 0.95. The coefficients for the same four categories when used to code the definitions of computer literacy ranged from 0.73 to 0.88.

The categories of computer use (see table 7) are self-explanatory, as are two of the categories of computer literacy and computer awareness (see tables 8 and 9). However, the "theoretical understanding" and "working knowledge" categories require further clarification.

The "theoretical understanding" category includes answers in which computer literacy or computer awareness was defined as follows: "knowledge of computers, understanding

Table 6

Numbers and Percentages of Schools at Which at Least One Teacher Using Microcomputers Was Teaching Each Grade from Junior Kindergarten to Grade 8

Grade	Number of Schools	Number of Schools at Which Grade Is Offered*	Per Cent of Schools
Kindergarten (Jr. and Sr.)	13	89	15
1	25	89	28
2	29	89	33
3	34	89	38
4	45	89	51
5	54	89	61
6	58	89	65
7	21	34	62
8	28	34	82

*The number of schools at which a program from Kindergarten to Grade 6 is offered does not include six schools that did not state the grades taught by the teachers listed, and the number of schools at which Grades 7 and 8 are offered does not include two schools that did not state the grades taught. Alternative schools were also excluded.

Table 7

Percentages of Schools Reporting Various Uses of Microcomputers

Use	Per Cent* (N = 103)
Computer programming	37
Remediation	31
Drill	26
Games	25
General enrichment	24
Computer literacy	14
Subject teaching	11
Fine psychomotor co-ordination	8

*One hundred times the mean estimate of three raters divided by the number of schools rated.

Table 8

Percentages of Schools Reporting Various Definitions of Computer Literacy

Definition	Per Cent (N = 95)
Working knowledge	66
Programming	41
Theoretical understanding	39
Awareness of effects on society	14

Table 9

Percentages of Schools Reporting Various Definitions of Computer Awareness

Definition	Per Cent (N = 89)
Theoretical understanding	48
Awareness of effects on society	42
Working knowledge	27
Programming	3

of computers, theory of computers, familiarity with uses, advanced knowledge". The "working knowledge" category includes answers in which computer literacy or awareness was defined in the following ways: "ability to use, hands-on experience, working knowledge, general understanding of working and scope, competence with the computer, ability to use beyond screen instructions, knowing how to load and run software". This category does not include any definition involving programming.

The percentages of schools reporting different uses of microcomputers are given in table 7. The percentages were calculated by dividing the mean frequency of each category by the number of schools answering the question. The percentages of schools reporting various definitions of computer literacy are given in table 8, while the percentages for definitions of computer awareness are reported in table 9. The percentages in these tables were calculated in the same way as were the percentages in table 7.

The last question asked for other comments about computer use. Of fifty-nine answers, only three mentioned any shortcomings of the microcomputer, and two of those answers referred to hardware problems specific to the school. Seventeen of the fifty-nine schools answered this question by stating a need for more equipment. Most of the remaining answers were clarifications of answers to other questions.

Discussion

The results of the survey suggest that the introduction of the microcomputer into Toronto schools has been recent and sudden. Of 112 schools with microcomputers, 104 reported that they had obtained their first in 1980, 1981, or 1982. Three-fifths of all schools with microcomputers had obtained their first one in a single year - 1981 - and a further 20 per cent reported receiving theirs in 1980. All but three of the 115 schools surveyed reported at least one microcomputer.

Other signs of the recent introduction of the microcomputer are the small numbers of computers at most schools, and the scarcity of disk drives and printers. Over half of the schools had only one or two microcomputers, and over 85 per cent had four or fewer. Barely more than a quarter of the schools had either a disk drive or a printer. The schools that had obtained their first microcomputers before 1981 were more than twice as likely as less experienced schools to have a disk drive and more than three times as likely to have a printer.

The descriptions by the schools of the uses to which microcomputers were put also suggest that the introduction of microcomputers is recent enough that they have not yet been integrated into the curriculum. Of eight types of use reported by schools, subject teaching ranked seventh in frequency. It was reported by only 11 per cent of the 103 schools who described their use of microcomputers. The most frequently reported use of microcomputers was in the teaching of computer programming. The microcomputer seems to be treated either as an end in itself or as an aid for teachers, who may use it to provide remediation or drill but who themselves undertake the main work of teaching. The reports of the places in which microcomputers were kept suggest that most of them are under the control of individual classroom teachers.

About a fifth of the microcomputers were reported as having been bought from funds other than board funds; this suggests that many schools are strongly interested in promoting the use of microcomputers. This possibility is confirmed by the finding that almost half of the schools reported that their use of microcomputers would be much greater this year than last year.

The reports by schools of their expectations regarding pupil and teacher use of microcomputers suggest that minorities of both pupils and teachers will use microcomputers regularly during the 1982-83 school year. Only five schools reported that most of their teachers would use microcomputers regularly. Nineteen schools reported that most pupils would use microcomputers regularly, and schools that had had microcomputers for a longer period of time were more likely to report this. However, only about a third of the more experienced schools reported this. Given that schools appear to be interested in promoting the use of microcomputers, this finding suggests that schools are unable to obtain as much equipment as they could use to accomplish their objectives. Seventeen schools did report that they needed or wanted more equipment, and more schools probably would have if they had been asked directly whether they needed more equipment.

Sixty per cent or more of the schools offering programs in Grades 5 to 8 reported that at least one teacher in each of those grades was using a microcomputer, while 40 per cent or fewer of the schools offering programs in Junior Kindergarten to Grade 3 reported that the teachers who were using microcomputers were teaching those grades. In junior and senior schools the grade and the number of teachers for each grade who were reported as using microcomputers were directly related. Kindergarten teachers were reported as using them relatively rarely.

Most schools defined computer literacy as "working knowledge", which chiefly means a knowledge of how to load and run software. About half the schools gave the most popular definition of computer awareness, which was "theoretical understanding". The two most popular definitions of computer literacy were the least popular definitions of computer awareness. It seems that computer literacy tends to be seen as the ability to run a microcomputer in some fashion, while computer awareness tends to be seen as a theoretical understanding of computer operations and of the effects of computers on society.

Part Two: The Fieldwork

Introduction

Microcomputers are a new phenomenon in society and have arrived on the educational scene unexpectedly and suddenly. In some respects those involved in their use are prepared for them, but in other ways they are not. In this report an attempt is made to show that the consequences of introducing microcomputers into a school system depend on who is prepared and in what ways. The problem of "preparedness" is crucial to the impact that microcomputers are having on education.

The project has focused on the question of what kinds of things happen in an elementary school system on the sudden introduction of microcomputers. More specifically, what kinds of interactions among administrators, teachers, pupils, and parents take place? What kinds of tactics are used by all involved to deal with the machines? What kinds of problems arise? What kinds of solutions evolve? Under what kinds of conditions do these kinds of interactions, tactics, problems, and solutions occur, and how do they affect all those involved in the situations surrounding the introduction of microcomputers? In finding answers to these questions, we discovered that most variations could be accounted for by the way in which each party involved was prepared for the introduction of microcomputers. "Preparedness" thus became a powerful explanatory variable.

The account should ring true and sound very familiar to insiders, but it is hoped that it also provides a new perspective and reveals something that is not already known. And, since insiders, especially those in stressful, unusual circumstances, do not always agree with each other on all matters, the authors have attempted to represent this disagreement in an honest fashion.

When an innovation is introduced into an organization (e.g., an educational organization) after weeks, months, or years of planning, informing, educating, researching, policy-making, and organizing, and when all those who are part of the organization want the innovation and fully understand its uses and advantages, then there is no question that there exists a highly developed state of preparedness. On the other hand, when some person or group in the organization is more knowledgeable about and/or desirous of the innovation than are other persons or groups, then there exists a different, a less well-developed state of preparedness. We call the way in which interacting persons or groups are prepared in relation to each other a preparedness context. It is within such a context that people or groups interact; these contexts are complex, can change over time, and interweave with each other.

If it is assumed that a number of persons or groups are party to the interaction, then the logical combinations of who is prepared in what way yield a great many types of preparedness context. For this part of the report, four preparedness contexts have been selected for elaboration.

These four contexts seem to be immensely important for what goes on when microcomputers are introduced into an educational organization.

Each section that follows in this part is organized around a specific preparedness context and the characteristic modes of interaction that appear within the context. For instance, there is the situation in which persons or groups with minimal authority or power in the organization are more highly prepared than those having greater authority or power. There is the situation in which persons or groups of the same type or at the same level in the organization are prepared differently and to different degrees, and in which they must deal with others who have more or less authority than their own, as well as varying kinds and degrees of preparedness. There is the situation in which persons or groups outside of and unallied with the organization are prepared in certain ways that strongly influence the organization. And there is also the situation in which persons or groups are attempting to become prepared by experimenting and exploring. These four types of preparedness context shall be referred to as, respectively, grass-roots preparedness, uneven preparedness, unallied external preparedness, and experimental preparedness.

The impact of each type of preparedness context on the interplay among persons and groups is profound, for people guide their talk and actions according to who is prepared and in what way. This part of the report traces typical patterns of interaction and links them with preparedness contexts according to the following paradigm: (1) a description of each awareness context, (2) an examination of the social structural conditions that enter into the context, and (3) an examination of the consequent interactions, tactics, problems, and solutions. Each of the following sections is organized according to the above design.

Grass-Roots Preparedness for Microcomputers

When an organization experiences an innovation, frequently persons or groups with limited authority or power in the organization are better prepared than those having greater authority or power. This situation can be described as "grass-roots preparedness". This preparedness can be in the form of intellectual preparedness, emotional preparedness, or a combination of both.

Persons or groups may be said to be intellectually prepared when they display a high level of understanding about the innovation, know how to implement the innovation, have carefully planned for the introduction of the innovation, realize the advantages and disadvantages of the innovation, and/or can communicate their preparedness to others. They may be said to be emotionally prepared when they display a strong desire to accept the innovation and do things with the intention of moving forward with it. Emotionally prepared people are very interested in the innovation and see it as important.

In the Ontario educational organization, pupils, teachers, and parents have limited authority or power when compared with principals, board administrators, board trustees, and ministry officials. When one or more of these groups displays a higher level of emotional and/or intellectual preparedness for an innovation (in this case, microcomputers) than those having greater authority or power, then a state of grass-roots preparedness exists. Some of the consequences of this context can be said to be positive, while others are not so positive.

Contributing Structural Conditions

There are at least twelve structural conditions that contribute to the existence and maintenance of a grass-roots preparedness context. They are (1) emotionally prepared pupils, (2) intellectually prepared pupils, (3) emotionally prepared staff members, (4) intellectually prepared staff members, (5) emotionally prepared parents, (6) intellectually prepared parents, (7) unprepared principals, (8) insufficient staff training, (9) limited policy development, (10) limited funding, (11) limited information and support, and (12) limited software.

Emotionally prepared pupils. A large number of elementary pupils love computers. They are eager and interested, and they want to get on with computers. This theme was repeated in countless conversations with pupils, parents, and school staff members:

> It's amazing how they take to computers.
>
> They are very impatient to use the micros.
>
> The students "demand it". It is really a tremendous incentive to children.
>
> At least one time during the year, we should have computers for everybody so that we can all learn about the use of them.
>
> Now, when kids have any spare time, they want the micro or nothing.
>
> The teacher and I arrived in the classroom at 8:50 a.m. A Grade 4 student was working on her multiplication tables at the computer. She had been there since 8:00 a.m. It was only when the teacher told her that it was time to go, that she left. She had no problems working while we stood and talked about the program. (Researcher)
>
> Students are fascinated and thrilled with computers.

> Young children clap their hands when successful with the micro. (Researcher)
>
> Kids are comfortable and casual with micros. (Researcher)
>
> If you don't have a micro, other kids will laugh at you. (Pupil)
>
> Children are very keen to talk about micros and have a lot to say. They are proud to show off their skills. (Researcher)
>
> The children find it difficult to ignore the presence of the micro in the classroom -- especially when it is in use.

Pupils want more computer training, more programs, and more time on the computers. They want to buy their own computers; in fact, many already have one at home.

Pupils also see computers as part of their future lives and employment. When asked, they will list endless ways in which computers will play a part in such areas as science, research, cooking, recreation, medicine, space, offices, banks, airports, automobiles, manipulation of human thought, and so on. In the words of others:

> The kids are technologically sophisticated.
>
> In terms of their views towards future use, the students make "adult" statements. It's like listening to parents.

Intellectually prepared pupils. Some pupils are quite sophisticated in their use of microcomputers and have become expert programmers. They are picking up these skills in school clubs, in outside clubs, in special courses such as the ones at George Brown College, from highly knowledgeable teachers in the system, from enrichment classes, and from family sources:

> The students in the club are so advanced that it is difficult to know where to go next.
>
> Some kids make very advanced and difficult programs.
>
> The kids are better programmers than the teachers.
>
> Some kids work at a higher level than using the computer as a tool. Some have a lot of "debugging" skills.

> I go to my Dad's office once a week to use the computers. They have three types of computers there: the Zenith the IBM personal computer and the Apple II. I have only used the Apple II.

Some play video games in arcades and shopping centres, while others acquire their experience at such places as the Science Centre and the Royal Ontario Museum.

Emotionally prepared staff members. While those teaching and non-teaching staff members who are emotionally prepared to become involved with microcomputers may still be in the minority, their numbers are rapidly increasing. Some have reached the stage of a strong emotional commitment and are extremely motivated; they tend to make very positive statements about the uses and effects of microcomputers:

> Micros have tremendous potential for teaching. They have unlimited educational uses. They are invaluable in a classroom.
>
> Computers are the thing for the future.
>
> Giving disabled children familiarity with something which they will use later in life is a more encompassing concept than academic achievement.
>
> Everyone should know about computers.
>
> If we are in the business of education, we need to be serious about computers. We can not dismiss them as a make-work program.
>
> Pupils will not be affected adversely by micros.

Such emotional preparedness is to be found even among school personnel who are completely naive about the whole field of computers. One social worker who was afraid to touch a microcomputer said she realized that sooner or later she would have to learn. Despite a lack of understanding and knowledge, secretaries, speech therapists, psychologists, nurses, counsellors, teachers, and administrators alike in this group expressed high levels of interest.

Some school personnel deliberately and firmly state that they are not afraid, do not feel threatened, and are willing to make an effort to learn. Others say, "Micros will not replace teachers."

This emotional preparedness is also more than just interest and belief in the potential of microcomputers; it arises from the perception of many that skills related to computers are a way of getting and keeping jobs in the teaching field. They can be heard to make such statements as:

> The writing is on the wall! Teachers are looking out for the future; fear of job loss encourages them to take courses.
>
> Teachers should be examined to make sure they are staying on top of current technological advances.
>
> I did not get a job in special education because I lacked a computer background.
>
> Our principal uses micros to create a high profile for the school.
>
> There is a need at the Faculty of Education to make staff more aware of micro uses in a variety of disciplines. Teachers feel personally pressured to take courses because of a fear of what the future will bring.

Intellectually prepared staff members. Schools that are making extensive use of microcomputers invariably have a staff member who can be easily identified as the "expert" and the main computer co-ordinator in the school. Sometimes this person is a principal or vice-principal; however, the person who emerges as the "expert", "promoter", and "co-ordinator" is much more likely to be some other staff member. This person frequently has a solid background in computers, which he/she has obtained at university, college, and/or in the business world. This person is often a science or math teacher, and in this respect it is interesting to note that the computer courses at the Faculty of Education at the University of Toronto (FEUT) were first limited to math and science people. The tasks and roles of this person with regard to microcomputers in the school can be extensive, ranging from those of technician to teacher trainer to writer of software (these will become clearer as the reader proceeds through the report), and are rarely officially recognized; that is, the person performs them in addition to regular teaching duties, perhaps out of the goodness of his/her heart or because of a strong belief that microcomputers are valuable in education.

Emotionally prepared parents. Many parents see computers as "the thing of the future" and talk about them in positive ways:

> From my experience in the business world, I have a very positive view on the future of computers.
>
> I see micro technology removing many menial tasks and providing more time for creative areas.

> I have friends who have micros at home and use them as part of their business endeavors. They don't have to leave home and can work at their own pace. They can have contact with their families and still provide an income.
>
> It is important for everyone to be involved with micros and to have some knowledge about their uses in everyday life. Canada must keep up as a world power.

These attitudes carry over to what parents want for their children. Since they are convinced of the future importance of microcomputers, many want their children to get as much exposure to them and to programming as possible. They want their children to develop to the fullest by learning with and about microcomputers. They want their children to be computer literate and to understand the history and the future implications of the technology:

> All children should be introduced to micros. They have to be able to work independently.
>
> It is becoming increasingly important for today's youngsters to learn computer operation and programming to better compete in the employment market later and to succeed in business.
>
> My advice to anyone regardless of age is to get as much training as one can, because everyone will have to live their lives with computers.

Even parents who do not have a microcomputer at home, can not program, do not use microcomputers at work, and have no knowledge of the machines whatsoever are still interested for the sake of the children.

Other parents are making efforts to become computer knowledgeable. They are learning from each other, taking courses from such places as George Brown College of Applied Arts and Technology, Upper Canada College, the TBE, and consulting firms. Some are teaching themselves or learning from their children. A substantial number have bought, or plan to purchase, microcomputers for themselves and for their children.

Intellectually prepared parents. Some parents are very knowledgeable about computers and use the machines in advanced, professional ways in their places of work and in their homes.

Unprepared principals. Teachers frequently talk about the important role that principals play in the schools and community and how the school priorities are set by the principal. With the sudden introduction of the new microcomputer technology, however, many principals have been caught unprepared. Many have had no previous experience with any aspect of computers and have had no chance, or are too busy, to get acquainted with the machines. Some in the over-fifty age group say they find it quite difficult to adjust. One principal who had been absent a great deal due to illness felt his school had "fallen behind others" in respect to micros. As one teacher stated:

> Principals should be involved. The principal has a great deal of influence. If they don't know what it is all about, they won't pay any attention to it, and the school will suffer.

Some principals are much more emotionally prepared - they are enthusiastic and interested - than they are intellectually prepared, and a few are prepared in both ways. However, on the whole, principals are less enthusiastic and prepared than many regular classroom teachers.

Insufficient staff training. The system -- meaning the Ministry of Education, the faculties of education of the University of Toronto (FEUT) and York University, and the TBE -- is not completely unprepared in the area of staff training related to computers, because courses, some of which are offered for credit, do exist. Teachers may apply for free in-service training (eight hours or twenty-four hours) which is given by the TBE in the late afternoon and in the evening, and there are special sessions for principals, trustees, and senior board officials. The board also gives a variety of workshops and has sponsored over one hundred teachers for the TVOntario course. There is a three-part specialist ministry course, set up according to specific ministry guidelines and objectives; the first two parts are offered for credit through the faculties of education, and the third part is now being designed and will be offered next year. The TBE also plans to offer the first part of the ministry course in the summer of 1983 and the second and third parts in 1983-84. Two non-credit courses are also offered at the FEUT; one is an introductory course, and the other is a course on programming.

In spite of the fact that the system has made these various courses available, there is still a strong feeling among many staff members (teachers, principals, and consultants) that the system is inadequately prepared in the area of staff training. These persons are frustrated because they can't get into a course (the waiting lists are very long), feel unhappy about taking a non-credit course, feel reluctant to take courses on their own time, would like to see courses offered on location, or would rather not have to pay course fees.

Limited policy development. Both teachers and parents expressed frustration over the fact that the TBE and the ministry have done little in the way of providing direction and making policies related to the use of microcomputers in elementary schools. (The policy that has been formulated will be discussed later in the report.) Here are several representative statements from teachers and other staff members on this topic:

> Right now, teachers don't know what to expect and what the expectations are. Just don't know what direction we are taking.
>
> The TBE administrators are not too aware of the revolution now taking place; maybe it is due to a lack of knowledge.
>
> The school system is behind with respect to computers. Things are happening very fast.
>
> No one knows what is taking place with respect to computers. A lot of sorting out is taking place right now. It is new to all of us. This includes the ministry, the boards, and the universities, right down to the teachers.
>
> Every teacher, school and board is at the moment doing something different.
>
> I find the lack of direction from the TBE frustrating.
>
> I am completely frustrated with the approach of the TBE. I am shocked with people who continue to think that computers are for "10 years from now" when they are really for "tomorrow".
>
> No one seemed to know and still doesn't know where we are going. The whole thing "crept up" on us. I don't think micros were introduced properly. The TBE and ministry should have researched the thing first and looked at what is involved, then made an informed decision. If it were not for the interest of teachers who, without any concrete TBE support, took the initiative, micros would not be around the way they are now.
>
> You can't inundate schools with micros when teachers don't know what to do or aren't interested.
>
> Part of the problem is that teachers have had a tremendous responsibility thrown at them.

> Ministry officials do not have enough microcomputer knowledge. They are putting the cart before the horse. There is little planning by those in charge.
>
> There is no pressure from the TBE regarding computers. The board is not helping. There is no policy.
>
> The ministry and board should get its priorities in order in terms of micros.
>
> The future use of micros depends on politics. The majority of teachers are neutral, waiting to go in either direction.

The following sentiments were expressed by parents:

> I would like to donate funds for the school's microcomputer program, but I was told to wait until the TBE and ministry developed a policy.
>
> The school system's use of microcomputers is poor.
>
> It should not be up to parents to decide whether or not computers should be used in instruction. It is up to the school system to decide.

Limited funding. Hardware (that is, microcomputers, printers, disk drives, word processors, monitors, and modems) is expensive and has led to unforeseen, unexpectedly large, financial demands on the school system, particularly during a period of budgetary restrictions. As well, it is only one of the expenses associated with the use of microcomputers; the costs of books, manuals, guidelines, technicians, repairs, courses, consultants, pilot projects, research, special furniture, installation, security, and so on must also be considered. Add to these prodigious costs the grim reality of rapidly changing technology and one has a scenario that can have a paralysing effect on decision making. Teachers and administrators frequently expressed frustration and concern:

> The technology is moving so fast that the micros will be obsolete in a few years - replacement will be a problem.
>
> The present technology will become obsolete in the near future; therefore it is important to stay on top of the advances to provide quality education in the classroom.
>
> Will micros get cheaper? Maybe the board should wait for bargains.

> Tapes from outside the system are expensive - $165.00. My whole classroom budget is only $150.00.
>
> There were no teacher supervisors on the project of making the software catalogue because there was no money to pay for them.
>
> More money is needed to do justice to microcomputers.

Limited information and support. Several departments of the TBE are involved with microcomputer hardware and/or software. The Science Department helps out with microcomputers, and the Special Education Department has its own machines which special education teachers may obtain. The Department of Inner City Programs provides money for microcomputers, while in the Mathematics Department each consultant has a microcomputer which is loaned to schools. The Computer Services Department has about a dozen machines that it loans to schools, and the departments of business education and technical education have allocated funds for the purchase of microcomputers. Individual orders for the machines can be put through the Purchasing and Supplies Department.

The Library Services Department orders books about computers on an ad hoc basis, in response to requests from individual staff members or schools.

The Teaching Aids Department has been asked to copy software and to do maintenance work, but because it has not received any direction from the TBE in terms of responsibilities, it has not made any statements to the schools. According to the co-ordinator, the involvement of this department is uncertain and limited because:

> There is a difference between routine servicing and maintenance. If teachers run into problems with the micros, they should contact the Maintenance and Construction Department (specifically the signals shop which services video equipment, TV monitors, tape recorders, radios, and so on), not us. Because of union contracts, teaching aids technicians are not encouraged to do this sort of work.
>
> We also have a problem with limited human resources. Although it is possible for teachers to get one of our technicians to copy software, it is not advertised because of the concern for being "swamped" with requests.

Two technicians of the Teaching Aids Department expressed their concerns as follows:

> I have as little to do with micros as possible. I'll replace chips when asked. When I get more pay, I'll service them. I could learn from the signals shop.
>
> The teachers are leaps and bounds ahead of us. I don't have a clue about micros.

The Teaching Aids Department has hired students during the summer to copy software and to work on downloading; at present, teachers can review programs and duplicate them in the department, providing they are public-domain tapes. The supervisor of the television and media section of this department is involved of his own volition in distributing software to teachers and introducing teachers to microcomputers (his actual responsibility lies with videotapes).

The bulk of the responsibility for introducing microcomputers into the schools is assumed by the newly created Department of Computer Studies and Applications. This one-person department monitors the distribution of microcomputers purchased through central funds by requiring that a school have at least one trained person on staff if it is to qualify for a machine -- in-service courses are run to train teachers. The department places orders for microcomputers once a year and gets a substantial quantity discount. Request forms for extra machines are sent to schools once a central budget has been established, and schools may request additional machines; at present, no school has more than four microcomputers purchased through central funds.

The formal duties of the co-ordinator of this department are as follows:

-- to work with other co-ordinators and consultants in the development and implementation of curriculum materials and programs in the area of computer literacy and computer appreciation;
-- to keep trustees and staff of the TBE abreast of current developments in information technology;
-- to assist in the development and distribution of computer software;
-- to act as a liaison person with other educational authorities and appropriate outside agencies;
-- to perform such other duties as the superintendent of curriculum and program may determine.

The co-ordinator of the Computer Studies and Applications Department and the supervisor of the television and media section of the Teaching Aids Department are both members of the Computer in Education Software Cataloguing

Committee.* All schools have received one or two copies of the Ontario Software Catalogue, which lists more than 1000 public-domain programs, of which almost 500 have been evaluated on a three-point scale by teams of teachers employed by the Department of Computer Studies and Applications. Copies of the best programs are being made and sent to every school.

To sum up, there are several departments of the TBE involved with various aspects of microcomputers. In some cases the responsibilities are ill-defined, and in others resources are lacking. Some departments are involved in an ad hoc, piecemeal fashion, and, because of a general lack of overall co-ordination of responsibilities among the departments, some needs are left unfulfilled. The TBE has made some very significant changes, and efforts have been and are being made to provide schools with information and support services, but all the demands are still not satisfied.

Limited software. Software, whether it is produced by industry or the TBE, is considered to be generally poor; there are endless complaints about its quality. A teacher who sat on a committee to evaluate the TBE tapes/programs maintained that seven of ten are useless. There is a feeling that too much emphasis (financial, as well as in terms of support services) has been placed on hardware and not enough on software. One teacher reported that he had a microcomputer in the classroom for a couple of months but found it difficult to implement any program, as he could not find enough good tapes. He said he lost interest and put the machine in the staffroom for someone else to use. A principal in another school said that the microcomputers were very much in demand during the first year, but not during the second year, as the teachers were disillusioned with the software and preferred not to have the machines unless they could make effective use of them. Another disappointed teacher said, "Such material would not be bought if it were in the form of books!"

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*The Computers in Education Software Cataloguing Committee resulted from an informal meeting in October 1981 of a number of teachers and consultants who had been involved during the summer of 1981 with a variety of student projects under Experience '81 and Summer Canada. The majority of the summer projects had involved the improving and cataloguing of public-domain software for educational use on microcomputers. With funding from the Ministry of Education, a teacher was hired to sort and catalogue existing public-domain software for the PET microcomputer. The result of that project was a catalogue of 1200 unique computer programs sorted on disks according to subject and grade level.

The literature is full of similar opinions about the importance of good software and the poor quality of existing programs. Frank Lambert, an American, wrote the following in an article entitled "The Classroom Computer is Naked!":

> Microcomputers are gathering dust in teachers' closets all over the country, and others are being used only for non-educational games, simply because they were purchased as the magic answer to teaching problems -- often without any courseware! In 1982, courseware is the only magic. It is the first consideration in computer-assisted instruction. (Lambert 1982, 87)

Ronald Ragsdale, a professor at the Ontario Institute for Studies in Education, has recently written about the misapplication of microcomputers in education:

> Providing individualized instruction by computer is simple from the computing point of view but extraordinarily difficult from an instructional design point of view. (Ragsdale 1983, 24)
>
> Schools are planning to make CAI the major application of microcomputers, when there is little good software available. (Ragsdale 1983, 25)

The complaints about software fall into several categories. First, it seems nearly impossible to take the existing software and use it as an integral part of the regular curriculum. Most programs have simply not been written to match the curriculum; sometimes no indication is given of approximate grade level, and often different kinds of material are offered in a fashion different from regular classroom materials. Teachers say that it is impossible to teach a subject with the software that is presently available. And since many feel that the computer is not effective as a solitary teacher but should be integrated into the curriculum as preliminary, complementary, supplementary, or follow-up material, this problem is most frustrating for teachers. Sandra Browne of A & S Financial Consultants Limited and Bernice Laski of Maurice Cody School attempted to integrate LOGO with the Grades 5 and 6 mathematics curriculum and encountered several problems, as these excerpts from their report illustrate:

> Each set of work sheets was developed with a specific purpose in mind and wherever possible the children were referred to specific pages in their textbooks which covered the same material as that being covered by the sheets.

> One of the difficulties with trying to develop material in this way was that, due to the different media which were used, different natural groupings and different emphases in subject matter occurred.
>
> An interesting feature of the LOGO implementation on the TI 99/4A computer is that it deals in integers only. All remainders encountered in division are blithely ignored.
>
> In LOGO it is easy to draw a regular polygon as long as one realized that the sum of the external angles through which the turtle turns will always be 360 degrees. Traditional mathematical treatment of angles in regular polygons deals with the internal angles.
>
> It is difficult to overemphasize the difficulty which can be experienced in trying to shift from one viewpoint to the other. Due to this factor, children working happily with angles in LOGO may appear to have no real understanding of angles when asked to work with a pencil and paper. (Browne 1983, 17-18)

Second, teachers report that the majority of the tapes are games such as Pet Man and Hard Invaders. Third, the academic programs are often just busywork of a remedial nature; instead, teachers would like such things as diagnostic tapes. Fourth, it is particularly difficult to use the software with Kindergarten and Primary children because the language is too difficult. Fifth, there is not enough variety; much of the software is boring and too easy. Sixth, there has not been enough software produced for special areas, such as French and special education. Seventh, the instructions and commentary on tapes are frequently poor. The instructions need to be simple and concise, and commentary such as "you dummy" is in bad taste. Eighth, some tapes lack short descriptions of what they contain. And finally, teachers often find errors and "bugs" in the programs and say they need severe overhauling.

Consequences of Grass-Roots Preparedness

Several consequences seem to flow from this grass-roots preparedness context.

School staff are making varied efforts to learn about microcomputers. Since many staff members are emotionally prepared with regard to microcomputers in education, many are taking the TBE and ministry courses. However, numerous others who want to take the courses have not been able to because the classes are filled to capacity. The consequence is that the courses designed and offered by the system are not the only way in which staff members are becoming familiar with microcomputers. Some simply decide to teach themselves: they use computer manuals, read articles, borrow books; they take school microcomputers home during weekends and holidays; and they buy their own machines. Others pick up knowledge from family members who may be involved with computers at work or who are studying computers in universities, colleges, or high schools. Some teachers are learning from the teacher across the hall; others are being introduced through short workshops offered by various staff members who themselves may be just beginning; and still others are participating in travelling labs and workshops run by persons recognized as experts in the TBE. A few teachers have learned from computer consultants (private enterprise people) in their neighbourhoods.

Courses and workshops are also being taken at such places as York University, the University of Waterloo, the University of Western Ontario, the Ontario Institute for Studies in Education, George Brown College of Applied Arts and Technology, the Skills Exchange Centre for Adult Learning, the Ontario Science Centre, the Ontario Crippled Children's Centre, the Institute of Child Study, TVOntario, the Metropolitan Toronto Separate School Board, the Board of Education for the Borough of Etobicoke, the East York Board of Education, and various high schools.

As well, many staff members now belong to computer organizations. The Association of Toronto Teachers Interested in Microcomputers (ATTIM) is particularly popular; here members can increase their knowledge, exchange materials, and meet other persons interested in microcomputers. The Educational Computing Organization of Ontario (ECOO) holds an annual conference that many attend; it also issues publications. The Teachers Pet Users Group (TPUG) is considered a good source of tapes and is frequently mentioned.

Teachers are creating software. The microcomputers are in the classrooms; good software that matches the curriculum and individual needs of the pupils is scarce; some teachers are very keen to use microcomputers and believe they have tremendous potential for education; and some teachers have good computer skills. The consequence is that some teachers are creating their own software, and many others have a strong desire to do so or to have input when others produce software. Some teachers believe that if they are not involved in the creation of software, they will be able to use microcomputers only in a limited, unsatisfying, and unintegrated fashion. This seems to suggest that the unpreparedness of the system and industry in the area of educational software has resulted in a creative force from teachers, or a case of "necessity being the mother of invention". However, some teachers and other persons claim that the system could never produce software that could be used by the individual teacher. Consider these remarks:

> Teachers should themselves know how, and be able to integrate the computer into the general curriculum. Integration can not be successfully done from the top.

> We can not rely on commercial software. Software must be produced by those using it; teachers must do their "own thing".
>
> I am interested in writing my own programs, as there are problems with those available. There is a mismatch between age and grade level.
>
> Is a board-wide system of tapes possible considering the issue of individualization?

Those teachers who do have the necessary skills are likely to be writing their own programs or adapting and changing the existing programs. Special education teachers, who are most involved with teaching for the individual child, often reported that they write tapes to suit their needs; they included reading-clinic teachers, teachers of children in behavioural classes, teachers of the physically handicapped, and teachers of children with learning disabilities and slow intellectual development. One special education teacher said she writes up simple programs on her home microcomputer and then brings them into the classroom and lets the children copy them on the screen and alter them if they want. Another said she sets microcomputer programs at home with the help of her husband. Another said, "I have to write my own programs." Other teachers, as well, are writing their own programs:

> I use unscheduled computer time to run off my own programs.
>
> I make my own programs and programs for other teachers.
>
> I spend a lot of time programming tapes for my kids.

There are other teachers who do not have the necessary skills to write their own programs but wish they did:

> Programs must be upgraded for teachers by teachers, keeping in mind specific behavioural objectives.
>
> I'd have to do my own programming. (Reading-clinic teacher)
>
> Programming has to be specific, tailored to specific needs, particularly to the level of each individual in inner-city schools where needs are so diverse.
>
> It would be better if teachers could produce their own software, but it would also be very difficult.

> I would like to be more knowledgeable and have more expertise so that I could adapt and change the existing programs. (Special education assistant)
>
> The guidelines regarding the use of micros are not applicable. We need individualized programs.
>
> When teachers create their own microcomputer software based on curriculum material specific to learning objectives, then the quality of software will improve.

And, there is also another set of teachers who have similar attitudes but instead of being actively involved in writing programs, would prefer to work with others who are expert programmers in order to produce software and satisfy their needs:

> Teachers and programmers need to get together to brainstorm for new ideas for programs.
>
> Instead of buying software, teachers should have access to someone for the skills the teachers want.
>
> A more efficient way is to have "idea" people team up with programmers. If the TBE is committed, they must release teachers who have ideas.
>
> There is a need to talk to find out what should be in programs. Maybe each school should have a liaison person to communicate with a central expert or authority.
>
> Good classroom teachers must be teamed with computer programmers and graphic artists.
>
> On the whole, good teachers can not be good programmers; programming is a very involved, complex task requiring total attention and plenty of time. Teachers need access to good programmers.

Errol Magidson, an American, has expressed a similar view:

> It is really not the machine that assists the student, but the co-operative efforts of instructional technologists, teachers as context specialists and programmers. (Magidson 1977, 20)

Finally, some teachers would like to be more involved in the evaluation of existing software. By this, they mean that they would like to serve on committees similar to those that the board has set up in the past in certain subject areas. These committees have rated programs in the Ontario Software Catalogue on a three-point scale and made the information available to other teachers.

School staff want more hardware. A third consequence of the grass-roots preparedness context is that staff members want more hardware. Statistics on the hardware currently in the Toronto elementary schools and the means of financing it are provided in part 1 of this report. Most schools have at least one microcomputer, approximately 25 per cent have a printer, and 25 per cent a disk drive. While estimates as to how many microcomputers are required vary, the demand for more is nearly universal:

> There should be one micro per floor.
>
> There should be one micro per two classes.
>
> Need one micro per two kids.
>
> The ideal is one micro per kid.
>
> Because there is only one in the class, it has been used for an introduction only. If we had a dozen or more, they could be integrated more.
>
> The TBE Computer Department says each child is supposed to have twenty-five to thirty hours of computer time leaving Grade 8, but this is impossible with only four machines and 200 Grade 8 pupils.
>
> Learning disabled kids don't get enough time on micros - they work slowly.
>
> Some teachers spend so much time preparing and editing tapes for their classes that they tend to develop a proprietary attitude towards them and refuse to share them. More micros would help.
>
> Lack of hardware decreases the desire to become computer-wise.
>
> I would like access to a computer to determine if it is a gimmick.
>
> It is difficult to retain skills without constant access to a micro.
>
> It is pointless to train teachers with such a lack of equipment.

Schools that have printers make extensive use of them, while many other schools aspire to have one. Printers provide concrete records of children's creative writing, remedial work, programming, and so on. They provide a tangible product that reinforces learning. One school is involved with a writing and publishing program in which the pupils type up their own stories and put them into the library. At the present time, a lot of the printing is done at a publishing company; however, if the school had a printer, the work could be done at the school.

Teachers and pupils had endless complaints about the time required to load tapes, and disk drives, which are faster, are prized.

The importance of printers and disk drives can not be overemphasized. In the words of one teacher, "Micros should come with disk drives and printers, as they are practically useless without these features."

Many schools also want word processors and TV monitors. Word processors help children in various writing activities, and TV monitors make it possible to demonstrate microcomputer programs to a whole class. A couple of schools have modems that allow access to the board's computer or other systems, and at least one other school reported wanting one.

Varied strategies are used to obtain more hardware. Schools are inventing and/or taking advantage of a variety of strategies in order to obtain more microcomputers and related materials. School fund-raising events are common; they include hot-dog sales, walkathons, cake raffles, the showing of movies at recess and noon, and the levying of fines for littering. One principal reported that his school wants to raise enough funds to buy twenty microcomputers, a printer, and a disk drive. Some felt that this was the only way to get the equipment they wanted.

Parents are sometimes the source of additional equipment, books, and manuals, either individually or through strong, interested, co-operative parent associations. They raise funds, donate machines, or facilitate the purchase of equipment at low costs.

A few school staff members have given microcomputers to their schools, and the Ontario Public School Teachers' Federation has provided funds. Classroom budgets are also used. Various special education facilities have used donations and grants to purchase microcomputers, and Commodore has given these facilities several machines.

Special schedules are devised. Another consequence is that some teachers and administrators have devised special schedules and arrangements to give pupils access to the limited number of microcomputers. Many believe that every child should have an opportunity to use the equipment and take great pains to avoid favouritism and competition by making sure that every child has the same time on the computer. Allowing pupils to use a microcomputer only when their work is done or allowing them to do remedial work and drill on the machine if they are behind in their work can have unexpected, unfortunate consequences. The "better" pupils may monopolize the microcomputer, pupils may pretend that they are doing poorly in their school work to get a chance to drill on the machine, or, paradoxically, those who are doing poorly will be rewarded by being given access to the computer. Pupils can end up fighting over the machine if they are assigned to it in pairs or small groups; the boys may dominate the girls; and those who have better computer skills may intimidate the not-so-knowledgeable. Pupils can become negatively disposed towards microcomputers if they must wait or are not given equal access.

All sorts of schemes have been devised to monitor microcomputer usage. In some cases microcomputers are rotated among classrooms and/or timetables (this is particularly difficult for schools on a rotary timetable); in others the microcomputers are situated in a central location and pupils are withdrawn from classes to work on them. Wherever the machines are located, pupils are often scheduled for limited times, usually ranging from ten to forty-five minutes, and can be seen watching clocks closely for their turns. Pupils are frequently required to sign schedule sheets which are placed near or on the computers. The following are some of the situations that were documented, and comments:

> There is a permanent micro in a classroom of thirty Grade 4 kids. Each kid uses it about one day a month.
>
> Grade 5 to 8 pupils are scheduled regularly for micro use, using the four micros in the resource room. Each pupil can use one for forty minutes per six-day cycle. They use it in pairs.
>
> The introduction of computers has altered the use of the library; it makes the library time very structured, which I don't like.
>
> The computer rotates from class to class on a two-week basis.
>
> We feel the micro schedule fits smoothly into our general school program. We have one hour per week, plus after-school time, and this is sufficient. (Pupils)
>
> Scheduling micros is difficult because of the inflexibility of our timetable. Each subject is strictly defined and must be taught for a specified time each day. It's not easy to fit micros in.
>
> One micro in a school is very frustrating. It is better to have no micros.

The class is divided into five family groups of six kids each. Each group has forty-five minutes on the micros.

The micro schedule is in a notebook on the table beside the micro. Pairs of students have twenty-five minutes at the micro. Each pair writes down ahead of time the period they want to work on the micro and the tapes they want to use.

After reading class, the teacher organizes the computer time for the day. The times are written on the blackboard and the student must read the time aloud before he or she is given that period. Since the class is a Grade 2/3 split, it is either a Grade 2 day or a Grade 3 day for the micro. The students are given fifteen-minute segments to work in.

This year, interested students were organized into groups of four and given thirty minutes of computer time in a six-day cycle. Each group was organized according to level of computer literacy skills so that each group would include advanced and starting students.

Daily Schedule for Bank of Micros

9:00 - 9:40:	Open unscheduled time (usually not used except by teachers running off their own programs)
9:40 - 10:20:	Math programs are used. (Students are free to choose the math program they want.)
10:40 - 11:20:	Word processor is used.
11:20 - 12:00:	Free use (programming, educational games, etc.)
1:00 - 1:45:	Free use
1:45 - 2:30:	Open unscheduled time (depends on needs of students)
2:45 - 3:30:	Free use
3:30 - 5:00:	Programmers' Club (Students from other schools come in as well.)
Saturday a.m.:	Programmers' Club

Other schools make no attempt at such rigid schedules and are not so concerned that pupils have equal access to the machines. In these schools schedules are much more fluid, or do not exist at all, with microcomputers being used at everyone's convenience. In some cases pupils may sign up and book themselves computer time according to their interests; in others teachers may assign pupils time on the machines on a random basis. It may be that no particular times are set aside for computer use; recess, noon hours, after-school hours, and Saturday mornings may be used. Some teachers pointed out that their microcomputers were underused, because the requirement that they be used with one or a few pupils conflicted with whole-class activities.

In schools that do not have disk drives tape loading is a time-consuming business and makes scheduling even more difficult. It also leads to pupil restlessness:

> I hate waiting for the tape to be ready. It is just a waste of time. We need a floppy disk to speed it up. (Pupil)

Consequently, teachers often select and load the tapes themselves. In addition to this inconvenience, the tapes themselves are often too long to fit into class schedules. This means that the allocation of time on the computer depends heavily on the length of the tape and the adjustments that can be made to the regular timetables.

A few staff members felt that teachers and/or pupils should be allowed to take microcomputers home to help ease the problems of access to limited numbers of machines. This is done in some schools:

> The teachers in our school fight over who takes it home on the weekends.
>
> The school's policy allows pupils with written parental consent to take machines home on weekends. This is not highly encouraged.

Clearly, most pupils and teachers spend only short periods of time on microcomputers, and some say they would not want to work on them too much anyway:

> I would get bored if I used it all the time. (Pupil)
>
> It would drive you crazy if you used it all the time. (Teacher)
>
> You should not use micros without some breaks.

Pupils interact and socialize. There are consequences of the grass-roots preparedness context for pupils as well. First, the simple fact that most schools have very few microcomputers means that pupils often work at them in pairs or small groups. Sometimes the teachers decide who is to work together; in other situations the pupils pick their own partners. Frequently the pairs or groups are of the same sex, but this is not always the case. The result is a high level of pupil interaction and socializing. There is usually a lot of conversation which can be noisy and disruptive. Even when one pupil starts out to work on a microcomputer alone, others are so interested that before long a small crowd will appear to watch or give advice. The following anecdote, written by one of the researchers, illustrates this phenomenon:

> The student was asked to show me a program on the computer. He selected a math tape which would allow him to work on some addition problems. He said that this helps him with his math. He brought a PET manual to the back of the room to show me some of the programs he understands. As usual, it was hard for the student to pull himself away from the computer to talk about its use. After going through several problems, the student switched to using a graphics program. By this time, several other students had joined us. As we talked, they all kept watching the screen and the development of the student's design.

With so few machines, the pupils must learn to take turns, to share, and to co-operate. The necessity for pupils to develop such skills in order to get the maximum use of the machines is seen by many teachers as highly beneficial. And because some teachers are barely able to function on microcomputers themselves and some pupils are more knowledgeable than others, the pupils teach each other. This sharing of knowledge and information among pupils develops their social skills. The pupils enjoy it, many teachers promote it, and the results are generally seen as positive:

> The Grade 6 kids teach the Kindergarten kids.
>
> The special education kids help each other.
>
> Senior school students from another school teach ours.
>
> I co-ordinate the school micros. I don't have the time to teach the kids in other classes, so I have my kids do it.
>
> Games which require co-operation are good.
>
> I like to work with my friends at the micro so I can share the excitement.

> Access to the computer has drawn socially different kids together.
>
> Students don't stare at the micro screen without talking to one another.
>
> Micros are good for alienated, shy students. Other students gravitate around them, and they begin to communicate.
>
> Because computers make you feel good, you make new friends.
>
> I have several boys who like to demonstrate their expertise. They love to go to another classroom and teach.
>
> The student who is very knowledgeable about micros gets a lot of attention.
>
> The computer enhances the social climate in the classroom. The students collaborate, assist one another, share and co-operate.

Pairing pupils can, of course, create problems. For example, some pupils with behavioural problems do not work well together. Those who are very good at computers can intimidate the less able. Pairing or grouping can also foster unhealthy competition and rivalry.

Sandra Browne had pupils work at LOGO in pairs and found that there are both advantages and disadvantages:

> The division of the class into teams generally worked well functionally with the two children tending to work together on the work sheets as well as the computer. This arrangement encouraged sharing and joint effort and helped the children to accomplish more than would have been possible otherwise.
>
> When a problem occurred on the computer that was beyond the ability of the team working on the computer to deal with, other children from the class would come over to help. Occasionally this help, or the help of one team member for another, would be counterproductive.
>
> Almost as soon as the field study started, some difficulties were encountered in forming or maintaining teams. The problems were encountered sometimes because of the illness of one partner, sometimes because a partner moved away, sometimes because of the

> failure of one partner or both to complete the required preparatory work, and sometimes because of conflict between the two partners. (Browne 1983, 21-22)

As well, there are pupils who, if they can find the chance, prefer to work alone:

> I prefer to work alone. You don't have to wait, and you can go at your own speed.
>
> I like to think by myself and be alone.

While working on a computer could bring about alienation and loss of human contact (several adults worried about this), the present set of circumstances in the Toronto elementary schools is producing exactly the opposite effect for the majority of pupils. Educators from other jurisdictions are reporting similar developments. Mary Alice White, an American, wrote the following in an article entitled "Synthesis of Research on Electronic Learning":

> The children who work around computers tend to talk to each other more than they do in the classroom and to talk about what is to be learned rather than talking about out-of-classroom matters. (White 1983, 15)

Pupils are providing input and expertise. A few pupils are involved in creating software and are co-operating with teachers in introducing microcomputers to the classroom. These pupils have invented programs that can be used by teachers in the classrooms and are helping teachers to work out program specifications. One teacher reported:

> I give a lot of credit to my associates, many of whom are my students. They help me invent, rewrite, and "debug" programs for teachers so that they suit the teachers' needs. I pay the kids $5.00 an hour from money raised through school lunches.

One librarian talked of a library program that a pupil had written and that the school was using, another of an audio-visual program that had been adapted for the TBE.

This input from pupils is considered to be highly desirable from two points of view: first, it allows pupils to apply their highly developed programming skills in a concrete context; and second, it helps the teachers.

The "pupil expert" in the classroom is frequently called on to teach microcomputer skills to the teacher and to the other pupils. The pupils usually enjoy this responsibility:

> I like it because I can fix it. When someone has trouble, they ask me, and I fix it. (Pupil)

The LOGO consultant, Sandra Browne, also used pupils with computer expertise to help the teacher and other pupils:

> As is true of most introductions to computers, insufficient attention was paid to the mechanical problems associated with using the computer. This was, however, not a major problem as some of the children in the classroom had computers at home on which they wrote their own programs. One student played a major role in assisting work in this area, and another played a minor role. (Browne 1983, 6)

Different teacher-pupil roles are developing. The introduction of microcomputers into the Toronto elementary school system within a context of grass-roots preparedness may be causing the evolution of different teacher-pupil roles and modes of interaction. The system is behind in and unprepared for training teachers, providing good software that matches the curriculum, and meeting the demand for microcomputers. Many pupils are emotionally prepared, and some are intellectually prepared. In addition, the microcomputer has new and unique characteristics never before encountered in the classroom environment.

Certain interviewees suggested that microcomputers will completely restructure the role and function of teachers, pupils, and the school itself and that the potential for new interactive patterns is tremendous. This may be so, but it is still too early to say. What has been described here is taking place against a background of the various elements of preparedness that now exist, and these elements may not exist in a few years' time.

The nature of the microcomputer is such that pupils can work at it with a minimum amount of teacher involvement. The microcomputer motivates, directs, teaches, provides feedback, and even allows for interaction and input. These are all roles that traditionally have been played by the classroom teacher. No other technology (not even television) has come so close to being "like a teacher". These characteristics of microcomputers were mentioned by both pupils and teachers:

> The computer is like a second person in the classroom.
>
> The computer is like a human in front of you. It has no feelings, though. (Pupil)
>
> I like the computer because you don't need another person to teach you.

> It is like a teacher.
>
> The computer adds a new dimension to the class. The class feels different just knowing it is there.

Given that microcomputers can fulfil several of the teacher's roles, that many teachers are poorly trained with respect to the machines, and that most software does not match the regular curriculum, it is not surprising that many pupils can be found working at microcomputers quite independently of both the teacher and the regular curriculum. Frequently, pupils select their own programs (or select from those approved by the teacher), load and unload the programs, and switch programs if they are dissatisfied with them. They work among themselves in pairs and small groups, teach each other, and organize and schedule themselves. Pupils work on microcomputers in classrooms where the teacher has little formal microcomputer training and can be of little help in the direction they take with the machines. Some teachers perceive this to be a natural and healthy arrangement:

> I do not attempt to guide the students. I let them do it themselves.
>
> Teachers should be facilitators, not experts.
>
> My students are free to work with what they want on the micro. They are free to try what they want.
>
> Students use the micros to practise what they learn at George Brown College. There is no one here who can help them.

Consequently, in many classrooms, pupils are experiencing two modes of instruction -- the human teacher and the microcomputer -- side by side and with very little overlap between the two. Teachers in these classrooms proceed with their regular activities according to their normal teaching styles and emphasize that microcomputers will have little impact on their role as teachers; what the pupils do on the microcomputer in these classrooms is quite separate and isolated from everything else:

> Micros won't replace the traditional methods.
>
> I can't see myself walking out of the room and leaving the teaching to the micro.
>
> Computers will not revolutionize society but will be adapted as additional tools to help people function better to realize their full potential.

> Micros will not replace teachers but will be an additional aid.
>
> Micros have not changed teachers' teaching styles.

Other teachers, however, believe that microcomputers will revolutionize education and that the capacity of the microcomputer to "act like a teacher" will eventually change the role of the educator. These teachers foresaw developments such as the following:

> Micros will take over a large part of the school environment. Teachers and teaching roles will have to change to adapt to this new technology.
>
> Kids' learning processes will change in the future from student-teacher to student-machine. The student will to a great extent control what and how much knowledge he/she will acquire.
>
> Teaching may become deskilled.
>
> The actual physical plant, the school, could possibly disappear as more and more instruction is done on micros which kids have at home. These are frightening implications.
>
> Teaching styles may become more fragmented to account for analyses of learning steps.

While, as mentioned before, predicting the future roles of teachers and pupils as related to microcomputers is risky, there are three observations about the present situation that can not be ignored and that strongly suggest that a revolution in education could come to pass. The first is that many young people love to work at computers; the second is that the computer can fulfil several roles of the teacher; and the third is that hundreds of children are now working at microcomputers quite independently of their teachers.

There is also a fourth observation that suggests that teacher-pupil roles and relationships have changed with the introduction of microcomputers; it is that many young people are more knowledgeable about computers than are their teachers. Teachers are learning from their pupils or are taking courses (e.g., at George Brown College) along with them. Pupils are demonstrating microcomputers to teachers and other adults at associations such as ATTIM (Association of Toronto Teachers Interested in Microcomputers) and at parent-teacher association meetings. The young people are frequently ahead of the adults, and comments from many individuals involved in this study, as well as in the literature, testify to the fact that they catch on quicker and with greater ease than do the adults:

> Young kids catch on very easily.
>
> Kids seem to learn faster and easier than adults, as they like to experiment -- their curiosity is there, so they just need the opportunity.
>
> After two years of computer practice, some students can create much better programs than the average teacher.
>
> Students find micros easy because they don't have to unlearn anything to approach them.
>
> In the classroom, where youngsters are being introduced to the machines as early as Kindergarten, they astound -- and often outpace -- their teachers with their computer skills. (Golden 1982, 51)
>
> We will never catch up with the Kindergarten kids; we weren't brought up to use the micros. It's like being in a different culture with different customs. (Grade 7 pupils)

Parents are providing input and expertise. Some parents who are emotionally and intellectually prepared for microcomputers are involved with them in Toronto elementary schools. As volunteers, the parents are training administrators, teachers, and students on the machines; selecting, editing, cataloguing, and writing programs; donating tapes; designing and conducting microcomputer courses; running microcomputer clubs; supervising students on the machines; teaching and informing other parents about microcomputers; and raising money. The following illustrate these activities:

> A volunteer parent who is a former high school teacher has developed and provided a five-week programming course for our Grade 4 kids.
>
> Parents work as volunteers in our school, with two working with teachers involved with computers. The parents spend time working one-to-one with the students (under the teacher's supervision) helping them learn to run, load, and become familiar with the micros. These parents have a background interest in micros.
>
> The micros in a spare classroom are staffed by a volunteer parent.
>
> The After-4 Club is run by volunteer parents.

> Parents supervise computers in the evenings in our school.
>
> A parent volunteer comes in once a week to do programming with the kids. The parent has access to four machines in the library. Arrangements are made with classroom teachers to send kids to the library, four to six at a time for thirty to forty minutes of instruction.
>
> Eight parent volunteers supervise the after-school microlab. The teaching instructor is a Grade 8 kid.
>
> Parents pay the school to give the kids a micro course.
>
> School pays a parent to teach micros to twenty-four teachers. A very useful experience.

Parents are also serving on committees with staff members and pupils to make decisions about microcomputers. Many parents want to be involved in the purchasing of and the planning related to the school use of microcomputers. They want the TBE to consult with them. In the words of two parents:

> It is important for parents to be actively involved in providing schools with equipment, materials and expertise.
>
> The TBE can't always afford such items for all schools; therefore, parent groups or individual parents should try to help to get the items for their home school.

Some parents are very curious about whether their children are using microcomputers and, if so, in what ways. They will contact the teacher to discuss microcomputers or even drop in to watch their children at work on them. One parent suggested that parents should be permitted to experiment with the equipment that their children use so that they will be able to communicate with their youngsters.

School staff want more information and support. Finally, as a consequence of grass-roots preparedness, school personnel generally want more information and support from the TBE with respect to microcomputers. Many school personnel expressed frustration in their dealings with the TBE on the subject of microcomputers. They are confused about whom to approach and claim the communication channels and procedures are "fuzzy". The following is a sample of the complaints and suggestions that were made:

The Toronto Board is not organized to deal effectively with hardware and software problems. The existing materials and procedures should be organized before more micros are purchased.

We do not know how to contact resource people.

The Toronto Board has too many people and departments dealing with computers. There needs to be more cohesiveness at the board level.

Procedures for obtaining software are very confusing. There is a lack of co-ordination.

There seems to be a problem of communication between the Teaching Aids Department and the Department of Computer Studies and Applications.

Tapes should be distributed like films -- borrow tape to download. Going down to the TBE to get tapes is offputting; even if you get there, obtaining the tape you need isn't always easy. They are not always receptive to your presence.

Tapes copied at the board won't load.

Information and software is not being sent to the intended recipients.

The board sends out large tapes, but programs have to be transferred to small tapes.

We need a central micro bank.

A central distribution system for tapes is needed with a resource person or technician.

Software distribution could be handled by the Library Services Department.

The board should develop a tape lending library for kids and teachers.

There is a problem in obtaining tapes. It is difficult to get to the TBE after school hours. The TBE should send tapes around to be copied and returned, or someone should come and show us what is available.

> Orders for tapes from the board are very slow. Board is often sold out.

Teachers complain about the lack of tape documentation. Though many tapes have been rated on a three-point scale and the Ontario Software Catalogue has a brief description of each program listed, teachers feel that more complete information on tapes is desirable. A few teachers and schools have begun their own cataloguing and filing systems of tapes that they have documented themselves.

Teachers and librarians want more library materials -- magazines, books, manuals, guidelines, textbooks, workbooks -- on microcomputers. A few librarians reported that any materials they had were constantly out on loan. Materials that are in the schools have often come from other school boards or from microcomputer companies.

Uneven Preparedness for Microcomputers

The grass-roots preparedness context is useful for explaining some aspects of the impact of the introduction of microcomputers to the Toronto elementary schools but, in itself, is much too simplistic. In actual fact, only some persons or portions of groups are better prepared - emotionally and intellectually - than those at a higher level of authority or power. Other persons or groups of the same type or at the same level in the organization are prepared differently and to different degrees. For example, Kindergarten pupils vary widely in their emotional and intellectual preparedness for microcomputers, as do pupils at all grade levels. Parents, teachers, principals, consultants, co-ordinators, administrators, and ministry officials also vary. This situation can be described as "uneven preparedness". An uneven preparedness context also exists and is maintained in an organization when policy formulation is slow and underdeveloped or, at least, is perceived by many to be so.

Contributing Structural Conditions

Four structural conditions of uneven preparedness context will now be described and illustrated. They are (1) uneven preparedness of school staff members, (2) uneven pupil preparedness, (3) uneven parent preparedness, and (4) slow, uneven policy formulation.

Uneven preparedness of school staff. Staff members' interests and abilities with respect to microcomputers vary widely. The emotional and intellectual preparedness of some has already been discussed in the section on grass-roots preparedness. However, not all are in such a state of preparedness. Many teachers and other adults are negatively disposed towards, or even fearful of, microcomputers. Some adults simply describe themselves as anti-machine; they are afraid that they would not be able to learn how to work one, that they would wreck it, or that the machine might be smarter than they are. They are shy and apprehensive about microcomputers.

Some teachers who know very little about microcomputers express their anxiety about them in terms of a fear of the unknown:

> Getting involved with a micro could signal a change in my lifestyle which I am not prepared for.
>
> Teachers are feeling very threatened by the appearance of micros in their schools. Some are panicking; others are buying micros to keep up.
>
> Teachers are afraid of the unknown. They are aware that computers are important and that they should know about them. The fact that they don't know creates anxiety. The real fear is not of the computer but of the unknown; it is not a "cop-out".
>
> There is still a fair amount of fear expressed by pupils at the FEUT regarding micros and their uses. About one-half of this class is fearful due to lack of understanding of how a micro works.

It was also not uncommon for teachers of English and French to say that they avoided microcomputers because they thought that they were related to mathematics.

Some teachers, administrators and parents are afraid that humans will become addicted to microcomputers and depend too heavily on them. They worry about marriages breaking down because one partner becomes "hooked" on the machine, and about children's personifying microcomputers and shunning human involvement as a result. They expressed concern about the violence of some computer firing games and its effect on children.

Fears were also expressed that children might lose special skills, particularly in the areas of reading, writing, and mathematics, because of microcomputers. While working on microcomputers, pupils may not be using their brains and developing their reasoning power. In the words of one parent, "How will these 'computer kids' think in the future? Will they be more rigid thinkers?" It is feared that creativity and communication skills might be destroyed. Microcomputers might take away the desire to read, or they could be used as a substitute for math so that pupils never learn the basics. One teacher expressed her opposition to microcomputers in this way:

> I worry about where the future kids are going to end up. I wouldn't have a micro in the house. I don't want my teenage daughter to be exposed. They can warp your mind -- stop people thinking.

Teachers are frightened because they sense that computers might change their role as educators. They fear that they might lose control if their pupils become more knowledgeable about microcomputers. They are uncertain of how to use the machines in the classroom and do not understand how pupils learn on them. They are afraid that computers will replace them:

> All teachers should be against computers if there is a possibility that teachers will lose their jobs.
>
> Female teachers will lose their jobs first.
>
> I am a Kindergarten teacher, and I feel that with time, micros will take over the teacher's role.

These kinds of fears and uncertainties are universally expressed among educators. For example, the following statement appeared in the January 1982 newsletter of the Science Council of Canada: "Computers will radically change the role of a teacher, but exactly what form this change will take is not clear." And Mary Alice White of Teachers' College, Columbia University made this comment in an interview:

> As a psychologist, I think that the work we have done -- which is massive -- on how children learn from print is well documented, but I think we haven't begun to crack the shell of what it is to learn electronically. (White 1981, 9)

The fact that microcomputers might be damaging to the health is another source of adult fear. The effects of radiation and damage to the eyes and posture are most frequently mentioned. One pregnant teacher said that she refuses to use the machine.

At times, negative reactions to microcomputers exist because adults feel that they are just a fad in education and will soon fade into history when their novelty wears off as have other fads. Some fear that microcomputers may be nothing more than a "gimmick" or an expensive toy:

> They are a glorified activity centre.
>
> They are an expensive distraction.
>
> Kids will just fiddle with them; they will get nothing out of it.
>
> Flash cards and other techniques do the same job as micros and are less expensive.

Finally, older adults in the over-fifty age group sometimes say that they are not intrigued with microcomputers. In the words of one older principal, "I feel too old to get involved -- I am frightened. I am too old-fashioned in my ideas about education. I can't see micros in the classrooms."

Uneven pupil preparedness. Pupils vary widely in their microcomputer expertise. Some have been exposed to the machines at home or through their parents' work; others have not.

Even within the school environment, some are getting more chances to learn about microcomputers than others. Certain pupils may volunteer or be selected to attend the George Brown courses, the TBE Saturday morning enrichment classes, or school microcomputer clubs. Some get more experience on school microcomputers because of stipulations teachers lay down as to who gets access to the machines; such stipulations may give access to those who deserve rewards, those who are bright, or those who need remedial work. Some pupils are in classes where the teachers are knowledgeable about microcomputers; others are not.

In an earlier section of this report, it was emphasized that many believe that the vast majority of pupils love microcomputers; however, there are pupils who are not so interested in them or who do get bored with the machines and/or the software. As well, not all students like to do the same things on the machines. Some are initially anxious when introduced to microcomputers while others get frustrated or agitated working on them:

> Micros are a waste of time. (Pupil)
>
> The students did not object when the micro left the classroom.
>
> The student was more interested in the baby chicks. (Researcher)
>
> I would rather draw pictures. (Pupil)
>
> The students become bored with the software and soon want to develop their own.
>
> The kids are bored with the games.
>
> It is frustrating when you can't do what you want with the micro.
>
> Some kids are very anxious about the micro. They get tense and call it names when they get the wrong answer. They sometimes accuse the computer of cheating or letting the other kid win.

> I was a bit nervous at first. I didn't know what to do. Every time the teacher asked me if I wanted to go to it, I wouldn't. (Pupil)
>
> Programming is repetitious and boring. (Pupil)
>
> We get bored only when the subject or game is boring. Like if you don't have to think about the game and you just push buttons. Games are only fun if they take thinking and if they are adventure and challenge. (Pupil)

Many teachers say that boys and girls are equally keen about microcomputers:

> There is no difference between boys and girls in their ability to pick up micro knowledge or in their desire.
>
> Once the kids are micro literate, there seems to be little difference according to sex.

Reports from other teachers and pupils suggest that boys are more interested in microcomputers, particularly at the beginning when a machine first becomes available, and are more likely to be aggressive about gaining access to them. Some girls feel dominated by the boys, and several teachers said that they had to intervene to give the girls a chance, after which the girls showed equal skills and interest:

> I have not seen any real difference between the girls and boys, although last year the boys were initially more adventurous. After a schedule was adopted and all had turns, the girls were more willing to explore the possibilities of the machine. Pairing girls together helps.
>
> Boys are more interested in the computer magazines.
>
> Math oriented boys are the ones who want to go to the George Brown course.
>
> I have to intervene to get the girls started, but then they love it.
>
> Older girls start to pretend that they can't work on the micro - fears start setting in about grade six. They don't think of it as feminine; they call the machine a "he".

> Girls are hesitant; the boys push them out.
>
> The girls would rather work by themselves without the boys.
>
> The boys help us sometimes, but they go too far; they play the game for us. Sometimes they are too pushy; we have to tell them to "get lost". (Girls)

An article in the Boston Sunday Globe written by Lois Coit entitled "Girls, Boys and Computers - Equal but Different" supports these ideas:

- There is no difference in ability or level of interest.
- There is a difference, however, in what male and female students like to do with computers.
- Equal access can be a problem, but it doesn't have to be. (Coit 1983, 21)

Coit cites several sources to make the points that (1) it is important for both male and female students to be encouraged to take advanced courses, (2) girls should be provided with female role models, and (3) schools should be careful to provide equal access.

Some teachers and researchers made the observation that girls are more proficient, attentive, and patient on the machines.

Uneven parent preparedness. Earlier it was noted that there are parents who are highly prepared emotionally and/or intellectually with respect to computers and that some are actively involved in promoting the use of microcomputers in the schools. However, a larger number are not conversant with the topic and are extremely naive about what their children are doing on the machines while in school.

Most parents have no microcomputers at home, and many do not use them at work. Few have formal computer training. Not every family can afford a micro, so many have no plans to purchase one. Some are traditional and resist innovation; they dislike modern things. Others feel too busy to get involved.

Slow, uneven policy formulation. The Ontario Ministry of Education has issued eight policy/program memoranda* to directors of education and principals of schools regarding computer technology in Ontario schools. Memorandum No. 31, "Computers in Education", which was issued on February 23, 1982, contained the only ministry policy on computers in education in effect throughout this study, however.

The purpose of Memorandum No. 31 was to outline the policy in the Ontario education system. It indicated that computers would be used for administrative purposes and by students for direct learning, and that there would be two fundamentally different ways to use computers in the process of teaching and learning:

> The more significant way will be the creative use of the computer by individuals; writing, composing, designing, analyzing and other extensions of original thought.
>
> The second, and currently the most prevalent way in which computers are used in education, is to gain access to learning materials and information resources. (p.#2)

The memorandum indicated that all students must be given opportunities to use computers in the first way but also warned boards not to make large-scale purchases of machines that would eventually be incompatible:

> During the 1982-83 school year, the Ministry of Education will provide grants for the acquisition of microcomputers that meet criteria which guarantee compatibility in the use of lessonware and courseware. It is anticipated that only limited numbers of computers meeting these approved criteria will be available during the 1982 calendar year. While the developments outlined above are taking place, and particularly during the remainder of the school year 1981-82, it

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*The following seven memoranda were issued on March 24, 1983, during the same month as the data collection for this study was completed: No. 67, "Functional Requirements for Microcomputers For Educational Use in Ontario Schools"; No. 68, "Provincial Assistance to School Boards in Acquiring Second Generation Microcomputers"; No. 69, "Educational Software for Ontario Schools"; No. 70, "Computer Studies Curriculum Guideline"; No. 71, "The Exemplary Learning Materials Project"; No. 72, "Planning for the Effective Utilization of Computers in Education"; No. 73, "Overview - Computer Technology in Ontario Schools".

> is suggested that although boards should refrain from large scale purchases, they should continue to acquire some microcomputers for specific use, in the way that purchases have been made to date.
>
> The ultimate necessity for compatible machines, and the announcement of grants which will support that policy, should not cause a delay in the progress of schools and boards towards the use of computers in the curriculum. (p.#3)

Many school personnel who participated in this study felt that the ministry's policy lacked the specifics and direction that they needed and wanted. Little was said in Memorandum No. 31 about which pupils should be involved with microcomputers; as a result, many school personnel were unsure about whether or not to get involved themselves, to what extent, and for what purpose. Instructors of in-service courses, formal courses, and workshops for teachers had little in the way of guidelines, directions, and structure for setting up their programs. Pupils were not required to learn about or use microcomputers as a part of the elementary school curriculum.

The TBE has established guidelines for Grades 7 and 8 to ensure that pupils have a degree of computer literacy before entering high school;* however, there is little provision for computer studies in Grade 9 in the secondary schools. Memorandum No. 70 indicates that a new curriculum guideline for computer studies, which will set out policy for the development of courses related to computers in Grades 10, 11, and 12, is in the final stages of production.

Consequences of Uneven Preparedness

A major consequence of the uneven preparedness context is controversy and diverse practices in a number of areas.

Controversy over priorities. Considerable confusion and controversy exists over the priority that microcomputers should be given in the Toronto elementary school system, and in actual practice the priority given them varies from school to school and from class to class. Some educators in the Toronto elementary school system are making microcomputers a top priority or are rapidly moving in that direction. They feel that the money is well spend and tend to assert that there is no way to escape the new technology and that they might as well adjust to it. The following comments are typical:

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*The guidelines suggest that pupils should have some understanding of the impact that computers are having on society, should be introduced to the careers created by computer technology, should be introduced to the operation of computers, and should have some understanding of computer programming.

> Computers are here to stay; the sooner we get involved in an organized way, the better we'll be able to take full advantage of the machine.
>
> It is the responsibility of the schools to train kids and prepare them for involvement with micro technology.
>
> It would be a mistake to disregard micros because of what they do and how they do it.
>
> Computers are just going to be here. To say that we can or should start at a particular stage or at a particular time in life or age is not important -- we can not control it.
>
> I would select a micro over all other material.
>
> Computers should be used for all subjects across all departments.
>
> Last summer when I suggested we spend $1200 on a printer, everyone agreed. (Principal)
>
> Micro must be a priority. It must be there.
>
> Special education kids should have as much micro exposure as possible. It is a way for them to become more knowledgeable of their environment, and micros are the environment.
>
> I feel that school priorities will change from a need for more textbooks to more and better software.
>
> Ultimately micros can be cost-savers, but software first needs improving.

Other educators are much more cautious, however, and warn against jumping on the microcomputer bandwagon. This viewpoint was summed up by one school staff member as follows:

> The thing is not to get involved with micros only because they are here but to carefully and slowly map out an effective and useful strategy for use in the class, with both teachers and students. We should go at it slowly, feel out the territory and see how things are going.

Still other school personnel question the cost of the machines and feel that they would rather spend the money on such things as photocopiers, stereos, science equipment, videotape recorders, books, workbooks, and human assistants. Some feel that what can be done on microcomputers can also be done without them:

> Can use paper for the same things. Micros are a frill.
>
> It is a sophisticated textbook. Visual learning isn't the only way.
>
> I haven't seen programs that could be more useful than dittos.
>
> I can see the micro as a tool but not the tool.

Some teachers are willing to have a microcomputer around, but maintain that it should not be the focal point; they say that the machines will never be able to replace teachers and books:

> You can't rely on them entirely.
>
> Micros are not an "end-all" or "be-all".
>
> I value books for reading; I am dubious of micros for that function.
>
> Computer should be a servant, not a master.
>
> We need language literacy before technological literacy.

Finally, there are those administrators and teachers who feel loaded down with other responsibilities and say that they can not cope with microcomputers:

> Micros are not a priority with me, although I see micros have made an impact in my school. My school is only able to respond to emergency situations at present, and micros are not in that category. (Principal)

> The board asks us to do so many other things -- we have little preparation time.
>
> Micros impose upon other important classroom and school activities.
>
> It is difficult to use a micro in the learning disabilities classes because other work must be a priority.
>
> The whole computer program depends on the individual teachers and their interest and/or keenness, which is not ideal. Micros are time-consuming for most teachers.

Controversy over goals and purposes. Considerable confusion and controversy exists over what to teach pupils about microcomputers and the function that the machines should play in the overall education of the children. In actual practice goals and purposes vary from school to school and class to class. Substantial numbers of teachers, parents, and pupils want microcomputer programming taught in the schools; they consider it an essential and important skill in today's computerized world. Many also believe that it helps children develop other skills such as planning, organization, self-discipline, and logical thinking.

Conversely, others are not convinced of the necessity of pupils' learning to program. They feel that it is sufficient for elementary pupils to be exposed to computers or to understand the concept of programming without actually being able to do it. Some reject the idea of teaching or learning programming on the basis that it is a boring, repetitious process. Consider the following remarks:

> I wouldn't want to program forever; it is boring once you know how it works. (Pupil)
>
> It takes a couple of months to make a really good program. (Pupil)
>
> If micros are for programming, forget it.
>
> I do not expect to turn out programmers. I expect my students to understand BASIC in a non-complex way. Students should become familiar with the capacity of the computer.
>
> The main goal at the elementary level is to have fun with the micro and to feel at ease.
>
> Kids should learn to be intelligent users. They don't need to learn how to program.

> Kids will just grow with computers. Schools, therefore, should allow computer programming to grow informally at the elementary level; that is, avoid formalizing it too much.

Part 1 of this report looked at the various definitions that school personnel give for the concepts of computer literacy and computer awareness. Regardless of exact definition, many cite literacy or awareness of computers as an important goal for elementary pupils. This can include the ins and outs of how computers work -- the researchers found that some pupils are a little vague about this:

> The computer is a "brain calculator". (Pupil)
>
> Have you got a brain in there? You have to have a memory of some sort or otherwise you wouldn't work. (Pupil to micro)
>
> I think computers are "intelligent". The game Android Nim gets more intelligent as you go. (Pupil)
>
> The micro has a brain like man. It thinks by itself. (Pupil)
>
> Does it have a battery? Will it run down? (Pupil)

Awareness and literacy can also include history of the technology, its effects on society, social issues and concerns, the computer's use and applications in society, future jobs and careers, educational implications, mechanics of operation, programming skills, tape-editing skills, or just simply use of the machines:

> I offer a history of the micro and possible uses before letting the students use them.
>
> Computer knowledge/literacy is inherent in its use.
>
> Students should know how to edit tapes; that is, have some degree of computer literacy.
>
> Mechanics should be part of computer literacy.
>
> Students have been doing a lot of awareness (with literature); but little programming.

> Social issues and concerns about micros should be integrated into the regular curriculum.
>
> I present information to kids regarding micro applications in the job world to get them thinking about their choice of high school programs. (Special education teacher)

Controversy over methods. Obviously, there are numerous aspects of microcomputers that can be and are being presented to elementary pupils. There are also a variety of opinions about the strategies that should be used to accomplish these goals. Some teachers, parents, and pupils say that microcomputers should be presented as a separate course, for which pupils would be graded. Others think that the machines should be used as educational "tools":

> Computers should be a subject so you understand what is going on in the world; to teach you about business and help you find information. (Pupil)
>
> We should have a period just for computers. It should be a separate subject. There should be a special classroom that has thirty computers and an experienced teacher. (Pupil)
>
> Elementary schools should provide a separate course for computers. (Parent)
>
> Micros should be used for reinforcement.
>
> Micro should be a resource.
>
> It is just another teaching tool. I use it at my convenience.

In using the microcomputer as a tool, some say, every effort should be made to integrate its use into the regular curriculum:

> I am integrating micros into my program for use in the regular curriculum. I do not see the micro as an additional activity. I see it as an integral part of the curriculum to help kids learn.
>
> Micro is part of seat work.
>
> The programs should match what the kids are doing in their regular English class.

Controversy over age. Considerable confusion and controversy exists over the age at which pupils should be introduced to microcomputers, and in actual practice the age for introduction varies from school to school and class to class. Many individuals commented on the inconsistency of the practices in elementary and secondary schools:

> There isn't a sufficient link with the high school program. The high school program repeats what the students learned in elementary school. The computer training is not continuous. Frequently it is not allowed in Grade 9. I have high school students who return here to work on the computers because they don't have them in the high school.
>
> Kids leaving Grade 8 with programming ability are beyond Grade 11 level at high school.
>
> High schools have computer courses. Why should Grades 7 and 8 pupils learn what will be repeated?
>
> Because so many elementary pupils are learning to program informally, it is possible that in five years' time the ministry's proposed Grade 10 computer studies course will be obsolete. That is to say, in five years' time, our present cohort of Grade 5's will have learned what the ministry proposes to teach them in Grade 10.
>
> I want to take computer studies in Grade 9. (Pupil)

Many Kindergarten and Grade 1 children are working on microcomputers, and some are programming. Numerous school personnel and parents strongly favour introducing microcomputers at as early an age as possible and claim that young children learn the skills quickly and easily:

> Little children do very well with the micro and word processor.
>
> I am surprised at how well the Grade 1 kids took to it.
>
> By exposing young children, I hope to ward off future anxieties about computers.
>
> Children should be exposed to micros at the Kindergarten level where most of the learning habits are formed.
>
> There is no reason why even small kids should not be doing programming. An eight-year-old boy of mine already programs fairly well.

> I want my child to learn at the primary level. (Parent)
>
> Introduce the young kids with simple math games.

Not everyone agrees, however, that Kindergarten and Primary children should be working on the machines. Some say that, for these pupils, human interaction is much more important and that it is essential for them to learn patience, discipline, and the basics first. Microcomputers, they say, should not be imposed on young children; their turn will come later. Others feel that the microcomputer is limited in its application to young pupils, since the latter may lack the necessary reading, number, and co-ordination skills, while still others complain that the software is not appropriate for that age level. Thus, many schools start children at the Junior level, and many parents, as well, favour the introduction of microcomputers at this stage.

Still others favour the introduction of computers in Grades 7 and 8, the level at which schools are likely to concentrate their microcomputer teaching because of the existence of TBE guidelines for these grades. And many believe that programming should be reserved for students at the Senior level.

The idea that there is a minimum age below which children should not be using microcomputers has been of almost no interest to the authors of articles, in both educational and popular journals, about the educational uses of microcomputers. Zeiser and Hoffman state that "very young children, even as young as 18 months, can use a computer to execute simple programs" (1983, 253). No other reference to this issue of age was found, and the literature describes users of microcomputers in elementary school as early as Kindergarten. Waniewicz, Rosen, and Rosensweig (1982) surveyed teachers using microcomputers in thirty-seven school boards in Ontario. While their sample was probably not representative, their finding that 55 per cent of their 694 respondents were elementary school teachers suggests that the microcomputer is well established in elementary schools throughout the province.

Controversy over type of pupil. Considerable confusion and controversy exists over what type of pupil should be introduced to microcomputers, and in actual practice the type of pupil being introduced varies from school to school and class to class. Frequently, however, it is the interested, the bright, the high achievers, the well behaved, the math-oriented, those with experience, and those with extra time who are selected:

> I selected seven kids to attend the George Brown course. The criteria for selection were based on class performance, behavior, and interest.
>
> You need good marks and experience to join the computer club. (Pupil)

> The kids who are ahead in their work are allowed to use the computer.
>
> All boys went to the George Brown course.
>
> The computer club held during school hours is only for those who can afford the extra time.
>
> The girls use it during class time because they finish their work first.
>
> Only the kids with computer knowledge (say from George Brown) are allowed to use the machine.
>
> The microcomputer will first be introduced to the gifted kids in the enrichment class.

Some administrators, teachers, and pupils firmly believe that microcomputer use should be optional and based on interest:

> I do not insist that uninterested students get involved.
>
> If you had to do it, it wouldn't be fun. (Pupil)
>
> No one is forced to participate in the travelling lab -- only if interested.

In contrast, staff members in other schools take the stand that every child should be using the microcomputer -- the bright and slow, boys and girls, regular pupils and special education pupils, pupils in Kindergarten and those in Grade 8, inner-city and non-inner-city pupils. Staff in these schools are apt to devise schedules that provide equal access to all students and to pair or group students so that some do not dominate others.

Controversy over teacher training and involvement. Considerable confusion and controversy also exists over priorities and methods for teacher training and involvement. There are teachers, parents, administrators, and pupils who believe that all elementary teachers should know about microcomputers since "computers are now part of education", "teachers will look stupid if they don't know when their pupils do", and "the more experience a teacher has, the more viable a tool it becomes, and the better it is for the pupils". Others, however, do not agree and feel that teachers' use of microcomputers should be voluntary; they would balk at mandatory involvement. In the words of one principal, "I do not pressure the teachers to get involved. The teachers use the micros in whatever ways they wish. I call this a 'process of familiarization'."

In schools where there is a staff member who is recognized as an "expert" in microcomputers, there are likely to be teachers who feel that they do not have to worry about learning and who say, "You don't have to know about computers to be a teacher."

If one takes the position that elementary teachers should become involved with microcomputers, there is then the problem of deciding what they should learn. Some say that, in order to make full use of the microcomputer, teachers should be able to deal with the more sophisticated concepts of programming; they should be able to write their own programs and teach and/or assist pupils to program. Others are not so sure, warning that programming skills acquired today will soon be obsolete. And there are a fair number of teachers who advocate learning just enough about programming to be able to amend, change, and "debug" existing programs. Still other teachers are strongly opposed to learning or teaching programming and say that an average teacher need only know the basics of how to turn the machine on and select and load programs; teachers should be facilitators, not experts. Then there are the nagging problems of whether teachers need to be technologists or repairers and whether they need to be familiar with the mechanics of such peripheral equipment as printers, word processors, disk drives, and monitors.

This lack of consensus as to what teachers should learn about microcomputers is also manifested in their comments about the various courses they have taken. Some will say a course was too basic, others that it was too advanced; some will be disappointed that they were taught programming, others pleased; some would have liked a general literacy course, others not; some expected to learn how to evaluate software, while others were not interested in this.

The methods for teaching about microcomputers to school staff members are also diverse and frequently the focus of discussions. Some courses are taught by means of textbooks and lectures, some instructors emphasize a "hands-on" approach, and some use films, while other courses are built around computer manuals that explain the workings of microcomputers and give step-by-step assignments. Some teachers believe that they should be introduced to microcomputers gradually, beginning with a brief workshop in the school, while others complain that courses are too short and simplistic. The following are some of the approaches suggested by teachers:

> To introduce the micro, we put one in the staffroom with posted instructions so that the teachers could play with it.
>
> The present TBE in-service program is scaring teachers; a PD day is all that is needed -- get teachers excited and then give them hardware and software. The micros will not sit idle.

> About 2 or 3 hours sitting playing with a micro will make teachers less anxious -- it is really attitude that is important.

Changing roles and responsibilities of school staff. Another consequence of an uneven preparedness context is that the roles and responsibilities of school staff in some schools are changing with the introduction of microcomputers. Schools that are making extensive use of microcomputers invariably have a staff member who can be easily identified as the "expert" and the main computer co-ordinator in the school. (For further elaboration of this point see the section on grass-roots preparedness.) This sort of arrangement can create certain tensions, as the following comments suggest:

> There is considerable stress for the person co-ordinating or directing the use of microcomputers in a school. This person has no set time for such activities.

> I am the main co-ordinator for microcomputers in the school this year, and I resent it. I have been instrumental in getting the teachers started and have called staff meetings to sort out ways to handle some of the problems, but some other arrangement has to be made.

> When only one person is extensively trained, demands placed on him/her by inexperienced staff are unfair and impossible.

Confusion about lines of authority and who should make the decisions about microcomputers also arises. One teacher reported that "The staff make inquiries of the principal, who lacks knowledge and interest, instead of the staff member who is knowledgeable and involved."

What about the schools where no staff member has emerged naturally as the expert? Some schools have called in experts from other areas of the system for help and advice -- there are perhaps half a dozen persons in the Toronto elementary system who have done extensive consultation and have established reputations as leaders in the field; they may or may not hold positions that officially recognize their work and abilities as such. At least one school has hired an outside consultant. But in many schools, the lack of an expert is seen as a serious handicap:

> We need a computer studies assistant to help teachers with the routine difficulties that pupils experience.

> We need someone to help us select programs and develop new programs.
>
> We need someone to talk to the teachers to alleviate their fears and to show the possibilities of micros.
>
> A resource teacher would be nice for advanced pupils.
>
> The school needs someone to co-ordinate at least half time. It is really a specialist position where the person would have to constantly update his/her knowledge.
>
> The idea of a computer consultant functioning as other area consultants do wouldn't be enough. We need a half-time enrichment teacher.
>
> Because of staff mobility, staff reduction, and illness, schools may be unfortunate and lose their computer expert or other trained staff members.

Sandra Browne, the LOGO consultant, found that written materials and instructions on the screen of the computer were insufficient for learning and that both pupils and teachers needed her expert advice:

> The instructions for how to save or to recall material from the disk are step-by-step instructions given on the screen as a set of questions. These instructions are simple enough that they could easily be used to instruct a machine. Nonetheless, without an expert demonstration of how the disk should be used, neither the children, the teacher, nor an adult observer could understand how to use the disk.
>
> This apparent inability or absolute refusal to learn from written material should constitute a thought provoking reflection on the methods which children are encouraged to use to learn new skills. More practically, it poses a problem in trying to create programs for rapid dissemination over a wide area where expert assistance is not always available. (Sandra Browne 1983, 6)

The teachers in some schools attempt to compensate for the lack of an expert by sharing whatever little expertise, experience, resources, training, and materials that they may have. One principal said, "I haven't worried about the problem of the expert leaving the school because I hope the teachers he originally trained will train others."

Even with an expert, the effective use of microcomputers in a school requires considerable co-operation on the part of staff members. They need to agree about uses, schedules, locations, and whether the machines should be a priority for pupils. Without such agreement, frustrations and jealousies can easily arise:

> I am unhappy that one teacher has both machines. It is unfair.
>
> I feel resentful that my kids don't get to use the micro.
>
> There is no point in one teacher teaching kids to use the micro if the other teachers don't want to follow through.
>
> We have to "fight" each other for the computers.
>
> Teachers at this school compete to be leaders re micros.

The introduction of microcomputers into the Toronto elementary schools has increased the responsibilities of many teachers. This is the cumulative effect of all the pressures for and against, positive and negative, from within the system and from without, which seem to converge on the teachers. Many are feeling tremendous pressure concerning microcomputers, and some are resentful:

> I consider the computer pilot project a tremendous sacrifice on the part of the staff. (Principal)
>
> The teachers' time is so fractured (French, gym, swimming, choir, ESL) that I don't want to see it fractured further with micro courses.
>
> The most pressing concern regarding computer use in instruction is the amount of pressure it places on teachers. They must rationalize its use.

Teacher after teacher, even the highly motivated and well trained, expressed frustrations related to time. The general consensus is that it takes a lot of time to deal properly with microcomputers:

> I do not have enough time to investigate what programs are available at the Toronto Board.
>
> It takes time to download tapes at the board.

> It takes time to supervise the microcomputer club after school.
>
> Modifying tapes takes a long time.
>
> Teachers should be responsible for deciding on relevant material and providing students with access to micros for educational use. This is time-consuming.
>
> The micros detract time from other areas. They are not time-efficient for regular class use.
>
> Teaching computer literacy is difficult -- it is not a required course. It is difficult to schedule because of the time element.
>
> Teachers and administrators haven't the time to take formal courses, preview and edit tapes, and make up programs.
>
> Time is the major hurdle in providing adequate instruction, reviewing programs, and relating computer use to curriculum.
>
> Loading the machine is time-consuming.
>
> Mrs. Laski, the classroom teacher, has summarized her experience in using this format to present material by saying that the preparatory work was absolutely essential to productive work. The primary difficulty was that the amount of work required was enough that many children had difficulty in accomplishing all of it so that they could use the computer. This meant that even though technical expertise was not required of her, she had to do a great deal of administrative work to ensure that the children had adequately prepared for their computer session. (Browne 1983, 16)

The enthusiasm of some pupils can also create problems for teachers:

> The kids are so involved, it is hard to keep them involved in their other work.
>
> The micro can be distracting. I have to do a juggling act. All heads go toward the micro.

> The kids tend to gather around the micro. I have to ask them to return to their desks.

Young pupils, some exceptional pupils, and pupils just learning to operate a microcomputer tend to need extra teacher supervision, often on a one-to-one basis. Some pupils can not be left alone with the machines, and others constantly check with the teacher as they encounter difficulties. All of this represents extra demands on teachers' time and resources.

Some teachers experience stress because the normal balance of the classroom is thrown off when a microcomputer is brought into the school. They must either select pupils to be withdrawn to use the microcomputer, devise schedules so that all have equal access to the machine, or allow children access to the machine on a random basis.

The lack of good software that matches the curriculum troubles many teachers. Some feel the need to compensate by writing their own programs to match the individual needs of their pupils; this requires extra time, even though some teachers enjoy it. Others may use the software that is available but feel obliged to organize and supervise its use carefully to prevent the pupils' time on the computers from becoming simply play.

Poor teacher-parent communication. Still another consequence of an uneven preparedness context is a breakdown in communication between many school staff and parents. Many from both groups are not prepared in the area of microcomputers, and communication is difficult when school policy is not clear and specific.

Reports of poor communication regarding the use of microcomputers in the schools were made by both parents and teachers. On the one hand, some parents claim that school authorities have provided little information:

> I have a very poor understanding of my child's experiences with micros.
>
> I do not know what micros are used for in the schools. I don't know what the school system's policy is.
>
> I have not been contacted by the school about micros. No one has discussed the programs or my child's progress with me.

On the other hand, some school authorities report a lack of interest on the part of parents:

> The parents haven't said much; there has been no response.
>
> We need a selling job on parents.

Unallied External Preparedness for Microcomputers

An "unallied external preparedness" context exists when an organization is under pressure to adopt and adapt an innovation that has been created by external agents who are mostly unallied with the organization. The pressure may come from the agents themselves, who feel they have much to gain from having the organization accept and use the innovation, or the pressure may come from society in general, which believes in the importance and potential of the innovation. However, when the innovation has been designed by unallied agents, the organization may find that the innovation as it exists does not exactly meet its needs. This means that the organization must use the innovation, with its shortcomings, as best it can, or that it must take steps to change and improve the innovation to match its own special set of needs and circumstances. This unallied external preparedness context is most useful in describing aspects of the impact of microcomputers in education.

Contributing Structural Conditions

There are at least three structural conditions that contribute to the existence and maintenance of the unallied external preparedness context in relation to microcomputers in education. These will now be discussed.

Industrial preparedness -- hardware. Microcomputer companies have manufactured many makes of machines, and they see education as a ripe market; in fact, business is perceived as putting tremendous pressure on educators to buy its products. Some educators and parents are critical and suspicious of this pressure from industry and wonder whether such a revolution in technology should be allowed to influence the education of children:

> Computer companies are simply out to make money; they have no interest in education.
>
> There is a pressure developed and manipulated by the computer companies to revolutionize society.
>
> I feel the computer companies are becoming very wealthy, and their advertisements are often untrue but convincing to the general population. The companies seem to be saying that if you are not computer literate, you are not "with it" and will be left behind socially and in the work place. Even young children will not respect you.
>
> The ministry seems to be under a lot of pressure by the business sector to implement micros in schools as soon as possible. Micros have been "pirated" in by the board and the trustees don't even know what is going on. Is it a way of getting out of a bad economic situation?

Industrial unpreparedness -- educational software. Industry has produced little in the way of good academic software and, since the microcomputer companies are neither educators nor allied with educators, may never do so. Some industrial programs, mostly in the form of games, do have characteristics that can be said to be educational.

Educators' unpreparedness -- software. To date, very little good academic software has been produced by educators. Few educators, be they teachers, principals, consultants, curriculum writers, or administrators, have had the chance to develop the skills necessary for the production of such software or to contemplate how microcomputers should be used in education.

Consequences of Unallied External Preparedness

Software is obtained from many sources. One consequence of this context is that software is obtained from many sources. Software falls into two groups: some is public domain, and some is copyrighted. In the case of copyright tapes, the TBE purchases a licence either to make as many copies as it wants or to make a limited number of copies. Teachers make extensive use of both kinds of tapes.

With respect to copyright material, it should be mentioned that it is very easy to copy such software, and while many are morally against such a method of obtaining software, others reported that they know "piracy" does occur. Unfortunately, such piracy reduces the incentive for producing good programs and may be one reason why good software continues to be very scarce. While no one knows for sure how extensive the pirating is, and most would rather not talk about it, one technician at the TBE related the following:

> There is a problem with copyright software. We have a standard procedure. The teachers have to write for permission. I've been asked to copy tapes. I've only had one teacher write a letter. You know what that means. It means that teachers are taking them home, or to friends and are making copies.

There are many programs available; the Ontario Software Catalogue lists more than 1000. However, as previously mentioned, the majority of these tapes are considered poor, and since the microcomputers are in the schools, the teachers and pupils are constantly scrambling to get appropriate and interesting software. Pupils bring programs of their own to school. They bring in games from family computers and tapes that they have made while taking special courses. One pupil reported bringing in tapes that he had pirated from his cousin in New York.

Teachers, too, acquire tapes from family members and friends. They obtain tapes from other teachers and use conferences and associations such as ATTIM to make exchanges. Various staff members in the Toronto elementary system who are recognized as computer experts have also been good sources of tapes. Other outside sources of tapes mentioned by teachers were the Metropolitan Toronto Separate School Board, the boards of education for the Borough of Etobicoke and the City of North York, the Dufferin Peel Separate School Board, the Ontario Institute for Studies in Education, George Brown College of Applied Arts and Technology, and the University of Waterloo.

Controversy over games. A second consequence of unallied external preparedness is that there is considerable controversy among educators over the use of games on microcomputers in the classroom. The microcomputers are in the schools; good academic software is scarce; a large percentage of the software can be classified as games; and most teachers are not well-enough prepared to produce their own software. Consequently, games are being used.

Some staff members are very uneasy about the use of games and worry that pupils view microcomputers primarily as toys:

> Kids learn games outside school; it is good for them to see the educational uses in school.
>
> The main purpose of using micros in the schools is to show kids that computers are not just toys. They have so much arcade experience with games.
>
> I am not too impressed with most games because of the violence. The violence is indicated not only by actions but also by noises indicating explosions and destruction.

Teachers with these attitudes towards games tend to put limits on when pupils may use such tapes. They may restrict their use to recess, noon hour, or after-school hours, or they may allow games to be used during school hours but only at a set time, such as Friday afternoons. Other teachers, particularly special education teachers, allow games, but only as rewards:

> I use games in the class only on certain afternoons when it has been a good day.
>
> The children are allowed to play games (ten minutes each) only after they have finished their work.
>
> I hope games are not abolished, as I use them as a reward.

Maintaining control over the use of games, however, is not easy, as the pupils love them. Several teachers reported that they can not get their pupils to do anything but play games:

> I can't get the kids off games.
>
> All the kids know how to do is play.
>
> The kids weren't interested when they found out they couldn't use games.
>
> Kids want to play games only; they don't want to work or learn. Kids will even bring in their own tapes from home to assure that they have games to play.
>
> Computers encourage you to play more.
>
> Sometimes kids try to get out of using the micro when it is used for work.

The use of games is also troublesome to control because many instructional programs are set up according to a game format, with the result that it is difficult to draw a firm distinction between playing and learning. One such program drills multiplication tables and has the appearance of a video game. In this program multiplication tables are drilled; the question appears on a spaceship, and the correct answer must be punched in quickly if the spaceship is to avoid being hit. The use of microcomputers with this type of program has the interesting effect of leading pupils to view learning as game-like and fun; this in turn makes it difficult for teachers to make up their minds about using them. Here are some comments from pupils and teachers:

> Kids see computers as part game - part instructional.
>
> Question: Is spelling a game?
> Pupil's Answer: Oh, yeah!
>
> You have fun and learn something at the same time.
>
> It makes teaching like a game.
>
> I allow games which have school content.
>
> Kids now think that learning should be made to look like a game.

There are teachers, however, who have no qualms about using games in the classroom, maintaining that they play an important role in introducing pupils to microcomputers and that they have educational merit. Chessboard, Othello, and Lemonade Stand are cited as game-like programs that teach logic and problem solving. Games, teachers claim, can be used as models for pupils in the programming of new games. Games help with perception, reflexes, speed, and attention span; they help to reduce fear of microcomputers, teach social skills, and are motivational. While more will be said of some of these uses later in this report, here are three typical comments:

> Games are a necessary stage.
>
> I can see using games at the Grade 1 level, as they help with turn-taking, waiting, seeing that others have a right to win, and so on. At this stage, the children are moving from an egocentric to a social level, and these skills are important and essential.
>
> Games motivate. Programmers can learn a good deal from the motivating factor of games. Even if games have negative factors, there is usually a great deal of personal strategy involved as well as the user's ego -- these are motivating elements which are very important. Many creators of educational software ignore this motivating factor and think of it as bureaucratic drudgery.

Finally, it should be noted that many of the parents who were interviewed or completed questionnaires objected to the use of games in the schools.

The popularity of open-ended programs. Open-ended programs are widely used and liked. This may be another consequence of unallied external preparedness context. The microcomputers are in the schools; good academic software which closely matches the curriculum is scarce; many teachers like to meet the individual needs of their pupils; and most teachers are not well enough prepared to produce their own software. The consequence is that open-ended programs are very popular.

An open-ended program is one that can be adapted or modified to suit the special needs of a particular class or an individual pupil; this is done by putting in one's own data, ideas, conditions or limits. The following is a sample of comments about these programs:

> Programs need to be adaptable. I have just recently begun to see a few tapes from the TBE that allow for built-in changes. This is a start.
>
> Last year Commodore produced a lot of programs that were "well-dressed". Programs without too many trimmings are better. When they are dressed with too many cosmetics, they can not be easily adapted. It is best to write plain programs.
>
> There should be changes in the design of software to suit the needs of teachers.
>
> Programs where timing can be controlled are good.

> Maybe programmed learning which is open would be more successful as opposed to programs which have always been closed.

Special education teachers were particularly keen to have open-ended programs for the reasons already noted.

Government initiatives. Another major consequence of the unallied external preparedness context is that the Government of Ontario is taking steps to make computer technology more suitable for education. Policy initiatives related to the application of computer technology in Ontario schools were set out in several memoranda on March 24, 1983. The following excerpts from these memoranda best describe the government's position and some of its initiatives:

> ... in the spring of 1981 ... the Ministry of Education in cooperation with the Canadian Advanced Technology Association (CATA), collaborated to design a preliminary study of the characteristics of a microcomputer for educational use.
>
> Subsequently, the Ministry has been developing a formal statement as to the functional requirements which microcomputers for educational use must meet in order to be recognized as extraordinary expenditure. The costs associated with this project have been funded by the Board of Industrial Leadership and Development (BILD). (Policy/Program Memorandum No. 67, 1)
>
> Beginning in December 1983, the Ministry is prepared to accept for evaluation, computer systems whose manufacturers believe they meet the Stage I Functional Requirements. The evaluation will involve internal assessment by the Ministry, pilot testing in classrooms and technical bench-marking by an external testing organization designated by the Ministry. (Policy/Program Memorandum No. 67, 2)
>
> ... the Ministry of Education and the Ministry of Industry and Trade have worked together to bring about the formation of a new Canadian company whose major corporate objective is to design and manufacture computers for the educational market place. This market place has been peripheral to the objectives of most existing companies,

> and it was felt that a significant industrial development opportunity was open to a company prepared to make the educational market its primary objective.
> (Policy/Program Memorandum No. 68, 2)

The new company has become known as the Canadian Educational Microprocessor Corporation, or CEMCorp.

> ... the Government of Ontario, on the advice of the Board of Industrial Leadership and Development (BILD) has authorized the Ministry of Education to place orders with CEMCorp to a total value of ten million dollars.
>
> These orders will consist of two million dollars worth of prototype systems, deliverable in the summer and fall of 1983, and eight million dollars worth of fully developed systems deliverable in late 1983 and throughout 1984, together with the necessary systems software.
>
> The prototype systems will be pilot tested in Ontario classrooms and will become the property gratis, of school boards providing testing facilities.
>
> The fully developed or "commercial" systems will be made available to school boards at a cost which is 25% of the manufacturers contracted price.
>
> The computer systems being developed by CEMCorp will be fully consistent with the Ministry's functional requirements.
> (Policy/Program Memorandum No. 68, 2-3)

> ... the Ministry of Education and the Ministry of Industry and Trade have collaborated, in co-operation with the Board of Industrial Leadership and Development (BILD), to institute a series of measures to assist the growth of an Ontario educational software industry.
> (Policy/Program Memorandum No. 69, 1)

BILD funding has supported and will support several measures including the establishment of the Exemplary Learning Materials Project (outlined in Policy/Program Memorandum No. 71), an advisory body, a process to identify and prioritize educational software needs, and a program of developmental grants to educational software producers. BILD funding is also used for the purchase of licences from educational software producers, for research, for cataloguing, and for co-ordination.

> To initiate these programs, BILD funds have been provided totalling $1.3 million in 1983 and $5.46 million in 1984.
>
> The 1983 funding will support preliminary work. The program for grants to producers and purchase of provincial licences will begin in 1984 and will be funded initially at five million dollars, growing to ten million by 1986.
>
> These measures are designed to provide support to an emerging private Ontario industry that can move to supply in large measure the educational software needs of Ontario schools. The expertise developed in supplying materials to Ontario schools which will meet the Ministries' evaluative criteria will provide a firm basis for success in other markets and ensure that Ontario teachers have full opportunity to enhance the learning of their students through the integration of quality educational softwares into the classroom program.
> (Policy/Program Memorandum No. 69, 3)

Experimental Preparedness for Microcomputers

When an innovation is introduced suddenly to a system (as microcomputers have been to education) in the contexts of grass-roots preparedness, uneven preparedness, and unallied external preparedness, everyone involved (in this case Kindergarten pupils to ministry officials) become experimenters in the struggle to understand the innovation. This situation can be described as an "experimental preparedness" context. Within such a context, there are few definitive answers; instead, dozens of ideas burst forth. Individuals in one part of the system may not know what those in other parts are doing and thinking; individuals at all levels may frequently change their minds about how to use the innovation; and much of the evidence regarding the advantages and disadvantages of the innovation is of an anecdotal nature.

Given the three contexts previously described, the experimental preparedness context is essential if the innovation is to proceed, be fully developed, and be properly applied. Without this context, the innovation would very soon become stale and eventually stall. For some, the experimental context is an uncomfortable state of affairs, but for others it provides an opportunity to create and to break away from normal routines, with a resulting release of energy and excitement.

Contributing Structural Conditions

The three contexts discussed earlier -- grass-roots preparedness, uneven preparedness, and unallied external preparedness -- are themselves structural conditions for the experimental preparedness context. However, there is one other important structural condition that contributes to the existence and maintenance of the experimental preparedness context; it is willingness to experiment.

Willingness to experiment. In order for the experimental preparedness context to exist and be maintained, individuals at all levels must be willing to experiment. If all the individuals at any one level refuse to experiment, then this context would no longer exist. If, for example, ministry officials formulated a policy that microcomputers must not be allowed in the elementary schools until high-quality academic software has been produced, or if large numbers of parents objected to their children's using microcomputers in the schools, then the context could not be maintained. In the case of microcomputers in the Toronto elementary school system, there seem to be a sufficient number of individuals at all levels -- pupils, teachers, principals, consultants, co-ordinators, TBE administrators, trustees, ministry officials, and parents -- who are willing to experiment for the experimental preparedness context to exist and be maintained.

The data in part 1 of this report show the extensive use of Commodore PETs in the Toronto elementary schools. The TBE has thus become an experiment in the use of PETs in particular and microcomputers in general. Many staff members are pleased that the TBE is proceeding with the introducion of microcomputers (PETs) into the elementary system and feel that the methods of doing so in an experimental preparedness context are good. The words of a few teachers and administrators best express these attitudes:

> The TBE has done a good job in introducing micros to the system. It hands micros out freely with few strings attached and lets teachers explore for themselves.
>
> The TBE lets teachers choose their own level of interest and involvement. Teachers would balk at mandatory involvement.
>
> The way in which computers have been introduced is good. The students are given the freedom to explore on their own. This reduces anxiety. Also, by letting the micros into the schools at this age, the students will not be anxious about micros in high school.

> The TBE has done a good job -- they got the machines out in the schools, which is good.
>
> The school has a good relationship with the board. The information about computers comes, and if teachers are interested, they use it.
>
> The Department of Computer Studies and Applications is doing a good job.

Various policies and initiatives of the Ministry of Education also maintain the experimental preparedness context, as the following excerpts from policy/program memoranda indicate:

> The ultimate necessity for compatible machines, and the announcement of grants which will support that policy, should not cause a delay in the progress of schools and boards towards the use of computers in the curriculum.
> (Policy/Program Memorandum No. 31, 3)
>
> The Exemplary Learning Materials Project was established in order to identify individuals and companies interested in, and capable of developing, a range of educational software directly related to the learning objectives in Ministry of Education curriculum guidelines and exemplary of current best practice.
> (Policy/Program Memorandum No. 71, 1)
>
> Two studies have been funded by the Ministry: one by the Board of Education for the City of Toronto to look at technology, use, and teacher practice to identify some possible themes and/or relationships; the other at Queen's University to study the creative use of microcomputers.
> (Policy/Program Memorandum No. 72, 4)
>
> Five school jurisdictions throughout the province are involved in pilot projects whose major purposes are:
>
> i) The identification of subject areas where computer applications have enhanced the existing educational program;
>
> ii) The identification of the effects of the creative use of computers in the classroom on teachers and pupils;

> iii) The refinement of evaluation for lessonware/courseware.
> (Policy/Program Memorandum No. 72, 5)

Other jurisdictions also believe in experimenting with microcomputers in education. In Lexington, Massachusetts (Watt 1983), the board has sought out interested teachers and encouraged them to introduce computers to their classes in whatever way they see fit. These teachers are to be models for other teachers, to produce ideas that appeal to other teachers, and to induce other teachers to use computers. After a three-day in-service training program, the board gave each of these teachers an Apple to experiment with. Sharkan and Goodman (1982) wrote the following in an article entitled "Improving the Climate for Educational Technology":

> To impose any innovation on teachers is fraught with frustration. Feedback from teacher workshops has suggested:
>
> i) The key to the operation of any instructional technology device is the individual faculty member.
>
> ii) The development or the evaluation/selection of meaningful software takes time. The school administration should recognize this and provide the time. (Sharkan and Goodman 1982, 12)

Consequences of Experimental Preparedness

A major goal of this study was to gather as many ideas as possible about the use of microcomputers in Toronto elementary schools, to communicate these ideas, and to establish themes for further experimental research. The ideas, of course, have developed from the TBE's use of PETs in most schools and LOGO in one classroom.

Commodore products well accepted. In a context of administrators, teachers, and pupils who were generally unprepared in their knowledge of microcomputers of any kind, the Commodore products have been well accepted:

> The PET is all kids need or will ever need at the elementary level.
>
> The PET is good because of cost.
>
> I love the PET. It has served its purpose well. The micro stuff is all positive.
>
> PET keyboard is easy.
>
> PETs are "kid-proof".

Some pupils and staff made suggestions for improvements in the PET that they believed would make it better for teaching and learning. Colour and sound were most frequently mentioned, while a few suggested the addition of joy sticks, larger screens, animation, more sophisticated graphics, and larger memory. Sticking buttons and screen glare annoyed some, and a few complained that the print on the screen is too small and stylized. Some reported problems with loading the tapes copied at the TBE and noted that programs are hard to locate on the tapes. A couple claimed that storage on the tapes is unstable and that programs have disappeared from the tapes while they were in storage over the summer. Physically handicapped pupils need special adaptations, such as guards, single switches, less sensitive keys, a wider keyboard, a larger screen, larger print, and slower timing.

Not everyone is happy about using the PET exclusively; some would like experiences with other machines and languages, and some would like to see all machines compatible. Some pupils and teachers prefer other products, such as the Apple, IBM, and Timex-Sinclair microcomputers, or wish that the PETs were smaller and simpler.

Numerous benefits and uses reported. Microcomputers are seen as having a wide range of benefits for, and countless uses in, education. Some uses have become quite well established in the Toronto elementary system; others are in the embryonic stage and are spoken of more in terms of their potential. Most uses have the character of new revelations. The uses and claims of benefits, most of which have not been subjected to formal evaluation, include the following:

1. Microcomputers motivate and instil confidence. Most pupils are highly motivated to work on micros; they find the machines friendly, nonthreatening and controllable. Comments from pupils to this effect are quite fascinating:

> The machine is pretty special to me. It feels like a friend. It is someone to be close by you.
>
> It doesn't kick you. It is not rude. It acts like a friend.
>
> I like the computer because it could work as a friend to everybody. It works like a friend because if you are mad it could calm you down. It could also teach you with equipment.
>
> It is easier to understand because it helps you go at your own speed.
>
> Micros are better than teachers because you can talk to them while using them. I like the micro because it doesn't take too long. The teacher doesn't have to tell you what to do.

> It's nice not to have a teacher standing over you telling you what to do.

Teachers confirmed what the pupils said:

> Micros allow for positive learning experiences. They remove the fear of failure, guilt, and punishment.
>
> The micro is a non-threatening teacher. When it tells the child he/she is wrong, the child is not resentful, because he/she knows the machine is not a person.
>
> Kids like the messages from the computer.
>
> Exceptional kids see micros as their friends.
>
> Kids like micros because they can go at their own speed and no one complains.
>
> The kids are in control. The micro gives the child its attention. The child doesn't have to struggle for its attention as with a teacher. It interacts with the child.
>
> The machine exhibits infinite patience, therefore removing a sense of embarrassment for wrong answers.
>
> The students are highly motivated because they can control the machine. They can make the micro do things for them.
>
> Kids have a deep interaction with the micro.

The universal enthusiasm of children for the microcomputer is widely reported in both educational and popular journals and has even been deemed worthy of an article of several pages in Time magazine (Golden 1982). However, all the evidence on the universal appeal of the microcomputer that has been offered is anecdotal. There has been little attempt to estimate scientifically the extent of elementary pupils' interest in the computer. The following are four anecdotes from the literature:

> It's the first math teacher that never yelled at me. (Conn Hughes 1978, 13)
>
> Children using a computer have a high motivation to work because they get immediate praise for correct answers, and they can work at their own levels of difficulty. (Vienneau 1981, H3)

> Children ... are extremely gratified by the responsiveness of a machine when they touch a button or turn a knob. It heightens the sense of being in control and comforts the child with its predictability. (Tittnich and Brown 1981, 20)
>
> Computer-related learning environments catalyze people to do outstanding work, because they provide a setting in which each student can create things, make things work (a computer, for example), obtain real recognition for work well done, and teach others how to do those things which he has learned well. (Bell 1974, 18)

The positive nature of the pupils' microcomputer experiences seems to instil confidence and increase self-esteem:

> Kids learn with less fear and guilt about making errors, therefore increasing feelings of self-worth, success, and confidence.
>
> They are good for self-esteem. The kids walk around saying, "I can work with a computer."
>
> The success rate in programs produces positive reinforcement beneficial for self-esteem.
>
> One student dropped everything, fell over everything, and seemed off-centre all the time until he got the micro. He seemed to immediately gain self-confidence because of it.
>
> The micro gives my special education kids a sense of accomplishment; thus they become more confident and unafraid.

2. Microcomputers are quick and easy to use. Pupils like the idea of "pushing buttons" instead of using pencil and paper. It is not only more fun, but it is much less laborious and considerably faster. Erasures can be executed in a flash, and new ideas entered in a clean, neat fashion. The pupils describe it as follows:

> You save on pencil, paper, and ink; you just press a button.
>
> The buttons are fun to press.
>
> It is different from being at a desk; you can type the letters instead of printing them. You don't have to write.

> It saves time.
>
> You can use the "delete" button and erase a whole thought.

Microcomputers provide pupils with immediate feedback and allow for instantaneous corrections.

3. Microcomputers always have the right answers. Children are impressed that microcomputers always have the right answer. They see them as having a brain and never making any mistakes. They say that you can not cheat with them and that you know right away whether you are right or wrong. One teacher said, "The machine is very factual. As a result, the student develops a very honest relationship with it."

4. Microcomputers are fun. Children tend not to see activities involving microcomputers as work, but instead regard them as entertaining and fun. They consider the work they do on the machines to be part game and part instructional; they frequently treat the machines as toys. The reader is referred to the earlier section on unallied external preparedness for a more in-depth discussion of the game-like quality of microcomputers and the pupils' and teachers' reactions to this.

5. Microcomputers can be used as rewards. Given that pupils have such positive attitudes towards and interactions with microcomputers, it is not surprising that the machines can be used as very effective rewards. Pupils are allowed to use microcomputers when they finish their work, for good performance, good behaviour, and so on. Microcomputer games are frequently used as special rewards.

6. Microcomputers can control behavior. Many teachers, particularly special education teachers, reported that pupils' behaviour changes for the better when they work on microcomputers:

> The machine takes on the role of therapist since it helps to modify behavior based on the intrinsic motivation generated by the micro and realized by the student.
>
> The machine is good for hyperactive kids. It removes frustration. The machine is neutral as a behavior modifier.
>
> There is no discipline problem when the kids are on the micro. They are happy, co-operative, polite, and well-mannered.
>
> A student who takes the Saturday enrichment class and is really sharp is not as much of a behavioral problem now that he can put his energies into the micro.

One of the researchers recorded the following anecdote:

> Four students were moving around the room, talking, yelling, pushing, and throwing books, boots, and chairs. One student was given computer time and the other three moved back to the machine with him. The noise level dropped drastically.

A few teachers said that they had pupils whose attendance and punctuality had improved because of the microcomputers.

7. Pupils concentrate on microcomputers. Teachers, including Primary and special education teachers, reported that pupils concentrate intensely on microcomputers and that their attention spans are longer when they are working with the machines than when they are involved in many other activities. Most teachers viewed this in positive terms, and some felt that it could be generalized to other activities. Many pupils talked to the researchers while continuing to work intensely on the microcomputers.

8. Microcomputers develop thinking skills. Working on a microcomputer is considered by many to be good for the mind. They say that it develops problem-solving skills and the ability to think logically and that many programs require a great deal of reasoning and forethought. Some say that it helps pupils learn how to plan and organize. One teacher said, "The organized thinking required for micros may generalize to other areas of life. This is more important than being stuffed with facts."

9. Microcomputers develop pupils' self-discipline, responsibility, and decision-making skills. Children must learn to be accurate and exact in interacting with microcomputers and to take meaningful responsibility for their actions; the simple consequence of not doing so is that the machines will not work. "It teaches the kids self-discipline," said one teacher, "and this is what we want." The pupils must be selective and must make decisions about what to do.

10. Microcomputers are challenging. Children find microcomputers a challenge. They like to compete with the machines to get all the answers right and often compete with themselves to improve their scores. One special education teacher said, "The micro is more challenging for the kids than I could ever be." Some pupils claimed that they find programming a challenge.

11. Microcomputers are good for eye-hand co-ordination. Some teachers believe that microcomputers develop eye-hand motor co-ordination and even use computer games specifically for this purpose.

12. Microcomputers are good for increasing speed. Children say that computers make them think faster because the machines are speedy, with instructions flashing on and off

the screen very rapidly. The response time on some spelling, mathematics, and reading programs can be controlled, so pupils can strive to increase their speed on a variety of activities, such as multiplication problems.

13. Microcomputers are good for teaching such things as learning sequences. Kindergarten, Primary and English-as-a-Second-Language (ESL) teachers sometimes mentioned that working on a microcomputer helps their pupils to understand sequences, order of operations, directionality, and left-right progression. A game called Number Seq is considered good for young children. Young children in particular also learn to follow directions through the use of microcomputers.

14. Microcomputers develop typing and keyboard skills. The use of microcomputers encourages the development of typing skills and teaches children the keyboard:

> It gives them a feel for the keyboard -- familiarization with the electronic age. They feel that they are modern, a part of the business world.
>
> Kids who learn to use the micro in Kindergarten will type faster as adults.

15. Microcomputers develop pupils' visual memory. This possible benefit of using microcomputers was advanced by a few teachers, but little elaboration was offered.

16. Creative writing can be done on microcomputers. Story Writer is one of the most popular and widely used programs in the Toronto elementary system. Children of all ages use it to write essays, stories, and other compositions. Teachers and pupils say that writing at a microcomputer is superior to writing at a desk for three reasons. First, the mechanics of writing are easier on a microcomputer. More exertion is required to write or print with paper and pencil than to push buttons, and the final product from a printer has a neater and more professional appearance. Second, editing is facilitated with a microcomputer or word processor; errors can be quickly erased, corrections neatly made, and deletions and additions more easily managed. Pupils often spell phonetically and then worry about corrections later. Third, it is easier to think at a microcomputer; inhibitions seem to be removed, and thoughts flow faster. The following comments from pupils and teachers are enlightening:

> I like the micro, as it gets the kids' "creative juices" going. They can do things on micros that they can't do on paper. Young kids don't have motor co-ordination to write well.
>
> Students use the Story Writer. They write and don't need to worry about punctuation. They can correct easily once they have their story put together.

> When you use a pencil, you just think and write anything. On the computer it is different -- you think along with it. It is very good for writing stories. (Pupil)

> Kids first correct each others' errors on the screen. I then go over it with them and make additional corrections related to their level of learning. The kids then run the story on the printer. The kids are very excited to see their own story in print. It enhances creativity.

> Story Writer is good for student sensitivity. Through writing, the students interact, share information, and help each other.

> The Story Writer is used over two-thirds of the time. In two weeks, one of the students wrote over seven pages! Another student who would not have written anything has done three pages in the same period. With the computer, there is no red line through the page, no rough, messy copy. It removes the tedium of writing. Besides, through the micro they have a chance to get published.

> Ideas come very fast with a micro; whereas, with pencil and paper they spend hours and come up with nothing. Students appoint their own proof-readers. The Story Writer has all sorts of potential.

Story Writer is even used with Kindergarten pupils. The youngsters tell their own stories with no help or coaching while the teacher or an older student acts as a secretary and enters it into the microcomputer. The stories are then printed out and can be displayed around the classroom or entered in binders.

Three stories written by elementary pupils on microcomputers are included in appendix C.

17. Microcomputers are used for drill, reinforcement, and remedial work. Microcomputers provide instant feedback and endless repetition combined with positive reinforcement and infinite patience. These properties make them excellent tools for drilling, reinforcing, and doing remedial work. Liane Heller wrote the following in a Toronto Star article entitled "'Well Done, Gabriele', Computer Tells Student":

> The computer has time - and infinite patience. Students work at their own pace. ... The program explains to a student why a mistake has been made. (Heller 1979, 11)

18. Microcomputers can be used for simulation. Lemonade Stand is the most popular simulation program; it is widely used. The program simulates the selling of lemonade and requires children to calculate profits, losses, and so on.

A few teachers reported using science-experiment simulators, such as the program Pollution.

One teacher claimed that, "Simulation games are very good if taken seriously."

19. Microcomputers are used for programming. Microcomputers are used to teach pupils of all ages programming skills. Teachers and pupils also use the machines to create new programs or to modify existing ones for use in the classroom:

> We like kids to be involved in making up programs for classroom use. This tends to make the programs more suitable.
>
> Programming appeals to many elementary kids.
>
> The teachers determine the program design, subject matter, and method of presentation. The kids do the technical part.
>
> I emphasize programming and the knowledge that one is in control of what a micro does and must make it do things.
>
> My kids are learning to program. (Special education teacher)
>
> It is impossible to stop kids from learning to program in the elementary schools.

20. Microcomputers are used to teach spelling. Many pupils reported liking such spelling programs as Hangman and Spd Spelling. One reading clinic teacher pointed out that the computer can be used without a program for this purpose; in such situations the machine functions simply as a "fancy typewriter".

21. Microcomputers are used to teach mathematics. Microcomputers are used extensively to teach, review, and drill math concepts.

22. Microcomputers are used to teach science. Science-experiment simulations are being used by a few teachers. Good science software is, however, scarce.

23. Microcomputers are used to teach geography. Geography games such as Open Pit Mine and Volcano Simu are being used to some extent. Good geography software is also scarce.

24. Microcomputers are used to teach French. A few teachers of French have begun to use microcomputers for tutorials and drilling. Again, there is a shortage of good French software, and teachers are not very familiar with what is available.

25. Microcomputers are used to teach music and art. Microcomputers, when modified for sound, can be used to create music, and this use is just beginning in the elementary schools. One boy said that he had created a tape of "O Canada" and another one commented, "It is fun because it gets you to imagine things."

Programs with the capacity to do graphics are very popular and can be used creatively for art purposes.

26. Microcomputers are used to teach reading. Microcomputers are effective in helping pupils learn to read. The children must read to run most programs, and since they are keen to work with the machines, they are motivated to learn to read:

> Kids must be able to read instructions fast, as they flash on and off the screen very quickly.
>
> It is a good motivation for reading. I used to have to force the kids to read. (Special education teacher)
>
> The kids never thought they would have to read to play a micro game.
>
> The students were initially surprised that they had to read and write to operate the micro. It can help you with your reading by asking questions. (Pupil)
>
> The computer keyboard helps young kids learn the alphabet.

27. Microcomputers are used to teach language and grammar. There is some limited use of microcomputers in this area, but teachers are more likely to talk about the potential that the machines have for teaching language and grammar. By simply using microcomputers, pupils become familiar with such things as spacing between words, upper and lower case letters, and verbs.

28. Microcomputers are used for the storing and retrieving of information. To quote one pupil, "You can store loads of information in a micro"; another said, "It helps you remember the things you need." Teachers and librarians, too, realize the storage capacity of microcomputers and are just beginning to use them in this way. Library research work can be facilitated through the use of computers. A few teachers and pupils are talking about getting modems to make it possible to access other data and information bases such as Telidon and Info Globe.* One child put it in a delightful way: "You can see the world through the computer."

29. Microcomputers are used for assessment and evaluation. A very few teachers are beginning to use microcomputers for assessing and evaluating students, while many more see the possibilities:

> If a printer were available, the micro could be used for assessment of students' work.
>
> I can chart the children's progress to a certain degree. (Special education teacher)
>
> It could be used for evaluation if schools were hooked up to a central computer.
>
> I collect information on student reaction and compile information on numbers of correct answers.

One teacher has designed a program that is an evaluative, diagnostic, prescriptive tool that teachers can use to individualize the mathematics curriculum for their students.

30. Microcomputers are used for office and library administration. One principal said that the uses for a microcomputer in a school office are limited only by one's imagination, and some schools are already making extensive use of microcomputers in this way. The machines can be used for writing correspondence, newsletters, and school newspapers; various secretarial and clerical jobs; producing course outlines, timetables, and budgets; keeping attendance and other records; recording marks; ordering and inventorying school supplies; compiling statistics, addresses, phone numbers; and so on. Some teachers are beginning to use them for similar purposes:

> I am making a program for report cards and marks.
>
> I am using the computer to keep track of students' marks. A program called Marks is available.
>
> We are having a student write a program to put sudent records on the micro.

Librarians are also using microcomputers for inventory and cataloguing purposes and to do such things as keeping track of overdue books.

31. Microcomputers can free teachers' time and energy. Once a teacher is familiar and comfortable with a microcomputer and the pupils know how to use it, the machine can free his/her time and energy for other duties. Some teachers are already using the computer to free themselves from routine, non-teaching tasks, while others are hoping to do so:

> The routine, mechanical, boring jobs are eliminated with the micro, and I have time for more creative pursuits.
>
> It should free my time -- it should be like an assistant.
>
> I hope micros will ultimately free some of my teaching time; for example, reduce marking time with self-correcting drills.

32. The microcomputer as an alternative methodology or tool. Many teachers perceive the microcomputer as a new and different teaching tool:

> The micro is an alternative methodology. It is fun. The micro is a novel way to teach. Another tool.
>
> I have been wanting an alternative method of instruction. The micro satisfies this need. (Special education teacher)
>
> There are hundreds of ways in which the micro can be used as a teaching tool. I used to teach a lesson with an overhead; now I use the micro.

33. Microcomputers are used with young children. Microcomputers are used with young children who are just beginning to learn letters and numbers. A few programs, such as Match Up Num, Missing Num, Counting, and Clock are appropriate for children with such limited skills. Some spell their names on the microcomputers, learn to count, do graphics, or become familiar with the alphabet. Some dictate stories into the Story Writer program, using an older person as a secretary.

Many Kindergarten and Primary teachers also use the microcomputer as an activity centre:

> With the longer school day, Primary kids need a lot of activities, and the micro is a good one. It is better than some other activities in that it is more instructional, structured, and not just play.

> I use the computer to keep the kids busy after the regular class work is done.

34. *Microcomputers are used with children learning the English language.* Microcomputers are used in ESL classes and with children in regular classes whose English skills are limited. As the following quotations indicate, the machines are used with these pupils for a variety of reasons:

> I use micros for drill practice, spelling, and verbs. (ESL teacher)

> I pair ESL kids with English knowledgeable kids on the micro. It helps them pick up vocabulary.

> Some games and programs stimulate the use of language. (ESL teacher)

> Micro use provides a common ground to bring kids of varied languages and cultural backgrounds together.

> The micro brings kids with poor English out of their shells.

> We concentrate on language tapes from the board, as most of our kids are from different ethnic backgrounds.

> A child with no English does great on the micro. It keeps up his interest.

> Children with limited language are very interested.

35. *Microcomputers are used in special education classes.* The many quotations scattered throughout this report from special education teachers attest to the popularity of microcomputers within these classes. One teacher said that Toronto board officials would be surprised if they knew how many special education teachers were taking the microcomputer courses. The benefits and uses of microcomputers in special education are those that have been outlined for all pupils in the past several pages; however, the following quotations are included to reinforce these concepts as they apply to special education pupils:

> Micros are very beneficial in special education. They give students confidence and help them grow and adapt.

> These students must earn the right to integrate back into the regular program. They are emotionally disturbed. Learning to share at the micro is part of their program.
>
> Micros are good for building group strengths among these children.
>
> It can be used as a visual aid -- visual/spacial concepts -- near point/far point focus.
>
> Micros are good in special education for variety, creativity, and individualization.
>
> Special education kids benefit and show tremendous progress on micros.

36. Microcomputers are used with physically disabled and hospitalized children. For many physically disabled children, microcomputers are just as important as wheelchairs. Those whose speech is affected and those who can not write or type can, with special adaptations to the computers, communicate through the machines. The visual qualities of the microcomputer also help in the instruction of hearing-impaired children. Microcomputers motivate the children and provide them with recreational activities. The machines also open up new educational and employment possibilities and make it easier for them to prepare for independent and useful lives. Their teachers strongly emphasized the importance of the machines for these children:

> Micros are a priority for these kids. It would be doing these kids a disservice not to allow them to use micros.
>
> The biggest use of the micro is motivational. In the final stages of some diseases, kids are frequently depressed. The staff has found that the micros help to occupy these patients, and in one case a teacher felt that the student's interest in a micro had helped to increase his life expectancy.
>
> The kids can now write all the stories in their heads, lengthen their communication lines, enlarge their educational possibilities, and be entertained with micros.
>
> Micro is very important. It is something the kids can handle and is a marketable skill -- one of the few possible.

37. Microcomputers have potential uses not yet explored. Many feel that microcomputers are not being used to the fullest extent in the elementary schools. Some say that the machines are in their infancy and that educators have not yet scratched the surface in using them, that the entire system has been caught unprepared in a phenomenon that is snowballing. These people feel that the majority of educators are not even aware of what computers can do, so the potential for teaching and learning with them will only be fully realized when both teachers and pupils are fully cognizant of their many uses. Others warn that computers will never reach their full potential in education as long as the software remains poor and the number of machines is limited. These people feel that if the problems are not solved quickly, pupils and teachers will soon become disenchanted with the machines.

Various methods used experimentally. Another consequence of the experimental preparedness context is that the TBE is trying a variety of methods for introducing pupils to microcomputers.

Because a course in learning to use microcomputers is not part of the regular curriculum, because there are a limited number of microcomputers in most schools, and because many teachers are intellectually unprepared for the machines, many pupils are introduced to computers through extra classes, clubs, labs, or special settings.

The TBE co-operates with George Brown College of Applied Arts and Technology in providing microcomputer courses for Toronto elementary school pupils at the George Brown campuses. Pupils, usually from Grades 5 through 8, are selected or volunteer for the courses in schools that decide to participate in the program (some schools are unaware of the courses). Teachers usually accompany the pupils to the courses and often take the courses themselves. There are usually thirty pupils per class, often from several different schools and grade levels. Each child is provided with one microcomputer. The pupils are taught rudimentary skills and some programming and are allowed to experiment on the machines. George Brown College supplies notes, tapes, and handouts and gives a certificate to each pupil who does two of three assignments. Pupils like the courses; they are learning about microcomputers in a new environment without the normal school pressures. The instructors sometimes find the courses difficult to teach, since pupils are at different levels in their knowledge of microcomputers.

The TBE runs two microcomputer labs, which travel from school to school to provide Grades 7 and 8 pupils with exposure to computers before they enter high school. Each lab is equipped with several computers, disk drives, monitors, and printers and remains in a school for a period of one month. Each group of pupils receives ten instructional hours related to computer awareness and ten to fifteen hours of hands-on experience. Teachers also participate in the labs, which have been generally well received.

Gifted elementary pupils may learn about microcomputers through the TBE's enrichment courses, which are held during after-school hours and on Saturday mornings. Each course is twenty hours long and is offered in ten sessions.

Several schools have microcomputer clubs, which provide pupils with the opportunity to become familiar with the machines. Pupils usually attend on a voluntary basis. The clubs may be led and/or supervised by teachers, parents, and/or pupils.

A few schools are involved with special pilot projects on computers, thus providing pupils with another chance to become involved.

And, of course, many teachers are working the introduction of computers into regular school hours and activities. As noted earlier in the report, some teach the children themselves, some make use of parent volunteers, and some have the children teach each other. Teachers use quite a variety of methods to get pupils started on and familiar with machines, including films, textbooks, manuals, flow charts, direction cards, programmable calculators, flash cards, chart analysis, notes, chalkboard lessons, instruction booklets, individual instruction, group instruction, and hands-on experience. Of all these methods, however, hands-on experience is considered by many to be the most effective.

Another very common practice is the posting of operating instructions near the microcomputers. One school laminated large instruction sheets and hung them up on an an easel near the computer in the resource room. Here is an example of a set of instructions that were observed near a microcomputer:

LOAD AND RUN A PROGRAM

1. TURN PET ON
2. INSERT TAPE AND REWIND
3. TYPE LOAD AND PRESS RETURN
4. LOOK FOR (PRESS PLAY ON TAPE #1) ON THE SCREEN
5. PRESS PLAY ON TAPE DECK
6. COMPUTER SHOULD INDICATE:
   - SEARCHING
   - FOUND "TITLE"
   - LOADING
7. WAIT UNTIL PROGRAM BEGINS OR YOU SEE A READY SIGNAL AND CURSOR
8. IF (READY), TYPE RUN AND RETURN
9. REWIND TAPE BEFORE REMOVING
10. IF LOAD (ERROR) REWIND TAPE AND REPEAT FROM #3 ABOVE

DO NOT

TOUCH TAPE WITH YOUR FINGERS
TURN YOUR PET ON OR OFF QUICKLY

Pupils must first be taught the mechanics of running microcomputers, and this again means that hands-on experience is essential. Children unfamiliar with the keyboard often require extensive instruction and practice on it:

> Not knowing the keyboard is a problem. We find that plastic practice boards help a lot.
>
> Kids say keys are not in alphabetical order and find the keyboard arrangement unnatural.
>
> Every time students spell a word, they seem to have to search for the right letter. Several of the children let their right index finger run lightly over the keys (from left to right and from top to bottom) until they locate the letter they want. (Researcher)

Children must also learn how to turn the machine on and off, load and unload programs, control brightness, control the cursor, and operate special keys such as the Return and Run keys. These details can be daunting to a beginner.

Pupils' abilities to deal with microcomputers and their previous knowledge, as mentioned before, vary widely, even at the same grade level; consequently teachers use different methods, adjusted to the children's needs and interests:

> Method of instruction is based on levels of difficulty, progressing from a basic level to an advanced level depending on the students' capabilities.
>
> Teachers must decide what students should know about micros; some students may need to know about programming; others need to use it to learn (as a tool); others need only know about micros generally.

Young pupils, some special education pupils, and pupils learning the English language frequently need special help and attention with microcomputers. The software language is often too difficult and the instructions too complex for them. The initial training period must be on a one-to-one basis.

Some claim that there is no "best" method of teaching about or with microcomputers, as pupils are all different and the uses of the machines are evolving.

Sandra Browne (1983) used worksheets to introduce LOGO to the Grade 5-6 classroom at Maurice Cody Public School. The worksheets were designed to introduce the children to the concepts of problem solving and included the following:

- a problem sheet, on which the problem and the session objectives were stated and the major principles and references that would be required to complete the work were introduced;

- a planning sheet, to assist pupils in the clarification and the rewording of the question and to allow them to make a plan to be carried out in the computer session;

- an observation sheet, on which pupils could record what happened when the plan of action was carried out;

- a log sheet to encourage the children to formulate and to interpret the relationships observed during the computer session.

The worksheets contained material that was part of the regular curriculum in mathematics and provided a series of problems that required initial work from the pupils at their desks. Sandra Browne also discussed methods of teaching the children the mechanics of using the computer and emphasized the importance of hands-on experience and live demonstrations. Appendix D contains several pages of Sandra Browne's report.

Various locations used experimentally. A final consequence of the experimental preparedness context is that the TBE schools are experimenting with where to locate microcomputers. Most schools were designed and built before anyone had ever heard of microcomputers; therefore, there is no single area in schools that is universally recognized as the "place to put the computer". Add to this the fact that there are too few microcomputers to meet the demand, and the result is that each school devises its own system for housing its microcomputer(s) and for meeting the demands of staff and pupils. Sometimes everyone is happy with this system, and sometimes not.

A multitude of factors must be considered in deciding where to put microcomputers. They have to be plugged in; they take up room space; a table surface is needed; peripheral equipment must be considered; glare can be a problem; security is needed in some schools; the machines are awkward to move around, particularly up and down stairs; they can disrupt other activities; they are used differently by teachers and students; and so on. The location of microcomputers in a school is also determined according to which staff members are trained to use them, or want to learn to use them, as well as the policy of the school on how many and which pupils should be given access to them and what the pupils should be doing with them. The personalities and teaching styles of those using the machines can also play a part in determining the location of microcomputers.

Many teachers have one microcomputer or several housed permanently in their classrooms, and many others would like such an arrangement. These teachers tend to be the ones who feel that microcomputers do not disturb regular activities and who want to be closely involved with what the children are doing on them. In these classrooms, the microcomputers may be kept behind a makeshift enclosure (e.g., behind the piano, behind filing cabinets), in a corner designated as the "Computer Corner", or beside the teacher's desk. Sometimes nearby drapes and blinds are closed to prevent glare.

Not all teachers, however, are enthusiastic about having microcomputers in their classrooms and advocate a "central location":

> We need a computer centre in the school which could take a class on a timetable basis.
>
> In addition to one micro for every two pupils, we need a microcomputer centre with at least ten micros "banked" and a set timetable for each class.
>
> It is difficult to schedule regular activities when the micro is in the classroom.
>
> Things get very noisy when the micro is in the classroom.
>
> There is no room in this classroom for a micro. (Special education teacher) I feel it is important for micros to be "banked" in an open, public area of the school so they are accessible to everyone who wishes to try them out.

Resource rooms, spare classrooms, empty offices, and libraries are common central locations for computers, but the use of the library creates the most controversy:

> The library is a good place for the micro. The special education kids are using micros in the library. It is a good arrangement.
>
> Micros in the library have limited use due to limited staff (the librarian is only half-time) and space.
>
> The micro in the library is disturbing to other programs.
>
> The micro has created chaos in the library. The students line up in front of the door long before eight o'clock. The library has almost become a playroom.

A third solution to the problem of where to locate the microcomputers is to move them around. Sometimes they are moved with the teacher trained to use them; sometimes they are rotated from classroom to classroom. This invariably requires special arrangements, for the machines and peripheral equipment are awkward:

> We have a trolley to move the micro.
>
> The caretakers move them at night.
>
> I can't carry the micro; it has to be made more portable. (Female teacher)
>
> I would like to see a computer table on wheels - a table which is recessed so that the computer can sit on it. There should be a plug in the table. It would be more mobile.
>
> The micros are going to get broken the way we move them up and down stairs and from room to room.

Several schools have both a central area with several "banked" microcomputers and a rotating microcomputer, while other schools rotate some computers and keep some in classrooms. This type of solution seems to be the most satisfactory:

> One micro is a permanent feature of the special education class, another remains in the science room, while the remaining two float around the school according to a schedule.

Security can be a problem, but many schools take no special precautions; in fact, some teachers are philosophically against having the microcomputer "locked up". One teacher stated this position as follows:

> Originally it was suggested that our micros be "locked away" in smaller offices, but I objected. I think micros should be in a comfortable situation - part of other things - not hidden away or viewed as some special, private activity. I like having the micro in an area where other people are coming and going and can see what is going on, and students can show what they are doing.

Some schools find it necessary to take special security precautions to protect their machines, peripheral equipment, and tapes from vandalism and theft.

Postscipt

Our intent in outlining the four preparedness contexts discussed in this report has not been to construct a typology of preparedness. Instead, our goal has been to describe different combinations of preparedness variables that appeared to characterize different aspects of the introduction and use of microcomputers in Toronto elementary schools and whose usefulness in predicting the course of institutional change could be tested in further research. The descriptions of preparedness contexts in this report should not be taken as summaries of findings, but as hypotheses about the relationships between variables that might explain the introduction of the microcomputer in Ontario schools. This report is not intended to be prescriptive. The utility of the postulated theoretical variables has not been established. Furthermore, the definitions of the theoretical variables are not intended to be complete and precise. They are instead initial formulations, which can be clarified through further research.

Our first recommendation is for further research into the validity of the theory. This research could include experimental laboratory research as well as field research in other school boards and in other types of institutions. The goals of this research could include the provision of general operational definitions of intellectual and emotional preparedness, which would be applied to different types of institutions. This research could also include examinations of the effects of preparedness contexts on such variables as productivity, morale, and so on.

One of the more important non-theoretical findings of the present study is the general dissatisfaction with educational software. A review of the literature failed to find a single article in which the effectiveness of educational software had been evaluated. It is clear that experimental research to evaluate the effectiveness of different educational software products should be carried out as soon as possible.

Another important non-theoretical finding of the current study is that microcomputers are seldom being used to teach material in the curriculum. Further research could establish whether this is the result of poor software or of other factors, such as the interests of the teachers who volunteer to use the microcomputers.

Research also needs to be done on the ways in which different types of pupils can most profitably use the computer. The teachers interviewed in the present study reported many ways in which microcomputers could be used with different types of pupils (ESL, exceptional, and so on), but did not discuss which uses of the microcomputer were not appropriate for such children. The appropriate educational use of the microcomputer may vary with the type of child using it. Variables whose effects quite clearly need to be evaluated are age and type of exceptionality.

Research could also be done to clarify the supposed motivating properties of the microcomputer. Teachers often reported that microcomputers motivate children, instil confidence in them, and so on. However, empirical evidence of their enthusiasm has never been reported. These anecdotal data may be misleading, and an investigation of the attraction of the microcomputer for different types of student would be helpful in the designing of software.

References

Bell, F.H. "Why Is Computer-related Learning So Successful?" Educational Technology 14 (1974): 15-18.

Browne, S. Toronto Board of Education LOGO Field Study Report. Toronto: A & S Financial Consultants Ltd., March 1983. (Unpublished Report)

Coit, Lois. "Girls, Boys and Computers -- Equal but Different". Boston Globe, February 20, 1983, pp. B2, B22.

Conn Hughes, Barry. "Your Kids and the Computer". Ontario Council for Leadership in Educational Administration 12 (January 1978): 12-14.

Glaser, Barney, and Strauss, Anselm. The Discovery of Grounded Theory. New York: Aldine, 1967.

Golden, Frederic. "Here Come the Microkids". Time, May 3, 1982, pp. 50-59.

Heller, L. "'Well Done, Gabriele', Computer Tells Student". Toronto Star, March 13, 1979, p. 11.

Lambert, Frank L. "The Classroom Computer is Naked!" Interface Age 7 (3) (1982): 84-89.

Maydison, Errol M. "One More Time: CAI is not Dehumanizing". Audiovisual Instruction 22 (October 1977): 20-21.

Ontario, Ministry of Education. Memorandum No. 31 ("Computers in Education"), February 23, 1982.

Ontario, Ministry of Education. Policy/Program Memorandum No. 67 ("Functional Requirements for Microcomputers for Education Use in Ontario Schools"), March 24, 1983.

Ontario, Ministry of Education. Policy/Program Memorandum No. 68 ("Provincial Assistance to School Boards in Acquiring Second Generation Microcomputers"), March 24, 1983.

Ontario, Ministry of Education. Policy/Program Memorandum No. 69 ("Educational Software for Ontario Schools"), March 24, 1983.

Ontario, Ministry of Education. Policy/Program Memorandum No. 70 ("Computer Studies Curriculum Guideline"), March 24, 1983.

Ontario, Ministry of Education. Policy/Program Memorandum No. 71 ("The Exemplary Learning Materials Project"), March 24, 1983.

Ontario, Ministry of Education. Policy/Program Memorandum No. 72 ("Planning for the Effective Utilization of Computers in Education"), March 24, 1983.

Ontario, Ministry of Education. Policy/Program Memorandum No. 73 ("Overview - Computer Technology in Ontario Schools"), March 24, 1983.

Ragsdale, Ronald G. "Misapplication of Microcomputers in Education". Orbit 14 (1) (1983): 23-25.

Science Council of Canada. "Policy Issues in Computer-aided Learning". Newsletter of the Science Council of Canada, January 1982.

Sharkan, W., and Goodman, J.E. "Improving the Climate for Educational Technology". Instructional Innovator 27 (5) (1982): 12-13.

Tittnich, E.M., and Brown, N. "Positive and Reactive Uses of Technology in Human Interactions". Journal of Children in Contemporary Society 14 (1981): 15-21

Toronto Board of Education. Ontario Educational Software Project. Toronto: TBE, 1983.

Toronto Board of Education. Ontario Software Catalogue. Toronto: TBE, 1982.

Vienneau, D. "Class Computer Is a Pied Piper for Grade 5 Kids". Toronto Star, April 18, 1981, p. H3.

Waniewicz, I.; Rosen, T.; and Rosensweig, D. Classroom Use of Microcomputers in Ontario: Teachers' Views on Equipment, Software and Support. Toronto: TVOntario, Office of Developmental Research, 1982.

Watt, Dan. "Educational Computing: The Two Cultures". Popular Computing 2 (6) (1983): 58-64.

________. "The Wired Classroom". Popular Computing 2 (8) (1983): 70-82.

White, M.A. "Into the Electronic Learning Era: Implications for Educational and Psychological Research" (interview). Educational Technology 21 (9)8 (1981): 9-13.

__________. "Synthesis of Research on Electronic Learning". Educational Leadership 40 (8) (1983): 13-15.

Winer, B.J. Statistical Principles in Experimental Design. New York: McGraw-Hill, 1962.

Zeiser, E.L., and Hoffman, S. "Computers: Tools for Thinking". Childhood Education 59 (1983): 251-254.

Software

The following programs referred to in this report are in the public domain and are listed in the *Ontario Software Catalogue* (1982), or the *Ontario Educational Software Project* (1983). The catalogues and diskettes with the programs on them are available at a minimum charge from Aurora Software Inc. in Haileybury, Ontario or Windsor Separate School Board in Windsor, Ontario.

- Android Nim
- Chessboard
- Clock
- Counting
- Hangman
- Hard Invaders
- Lemonade Stand
- Marks
- Match Up Num
- Missing Num
- Number Seq
- Open Pit Mine
- Othello
- Pet Man
- Pollution
- Spd Spelling
- Story Writer
- Volcano Simu

Appendix A: Methods Used in Part 2

Five research technicians (known during the project as observers) were hired to conduct interviews and to observe classes. Interviews were conducted with teachers, other staff, and pupils at eighty-three elementary schools of the TBE. Observations of classes were also made at these schools. Parents' and guardians' opinions were solicited by questionnaire or at interviews in their homes. Administrative staff and the staff of other institutions involved in the use of microcomputers in the TBE were also interviewed. A grounded theory approach was used to code interviews and observations.

Guidelines for Observers

The observation team met on November 1, 1982, the day before the first visits to the schools. The grounded theory approach (Glaser and Strauss 1967) was outlined by the principal investigator, and the observers were assigned readings about it. They were told to conduct interviews with as many teachers, other staff, and pupils as possible in the schools they would be visiting, and to be non-directive in their conduct of the interviews. They were told to take notes in each case, providing as complete a reproduction of the actual interview as possible, but not including in these notes any evaluations or judgements of what was said to them. The observers were also told to arrange observations of classes whenever possible and to provide similar non-evaluative notes of them.

Sampling of Schools

The information collected in the survey of schools was used to define samples of schools for observation. It was decided to begin with those schools that had given the modal responses to the survey questions that dealt with the number and make of the microcomputers at a school, the year in which the first microcomputer at a school had been obtained, the places in which microcomputers were kept, the grades taught by teachers using microcomputers, and the use of microcomputers in special education. This meant that the first sample consisted of schools having one microcomputer, a Commodore 4032, which had been obtained in 1981, which was being used by a teacher who taught a Junior grade, which was kept in a single classroom, and which was not being used in special education.

Schools were selected from this sample for the first two weeks of observation (November 2-15, 1982). The samples for the ensuing weeks were chosen so as to provide informative contrasts with the earlier samples or to allow the observers to reconsider the types of school observed previously in the light of their observation in contrasting types of schools. The samples for the remaining weeks before Christmas were as follows:

- November 15-19: schools having one or two microcomputers kept exclusively in individual classrooms and used by teachers of Grades 4 to 6;

- November 22-26: senior schools having one or two microcomputers;

- November 29-December 3: schools having a total of one or two microcomputers, which were used in Kindergarten to Grade 3;

- December 6-10: a selection of schools from each of the samples previously drawn, plus one school having more than five microcomputers.

From January 10 to February 11, the schools visited during a week were not drawn from a single sample. The schools visited during these weeks included schools having more than five microcomputers, special schools under the jurisdiction of the Metropolitan Toronto Board of Education, schools having microcomputers used in special education classes, and schools run by the hospital and institution program of the Special Education Department.

From February 21 to March 4, schools having fewer than five microcomputers, used in the Junior grades, were visited, so that the last five weeks of observation would be spent at schools where microcomputer use was most typical.

During all weeks of observation it was necessary to include in the schedule schools from outside the designated sample, because in each case some schools in the designated sample were unable to take part.

Arrangement of Visits to Schools

Visits to schools were arranged with the principals or with staff members designated by them. The researchers suggested a length of time for each visit, but the schools had the final say about how long the visit was to last. The suggested length of a visit varied with the number of schools already booked for a week, with the maximum time being three days. The actual length of the visits varied from a few hours to three days, with most schools being visited for at least two days. Altogether, the visits included eighty-three schools and nine centres run by the hospital and institution program.

Other Interviews

Interviews were also held with many non-teaching employees and consultants involved in the introduction of microcomputers. Faculty members at George Brown College of Applied Arts and Technology who were teaching Toronto students and teachers were interviewed, as were faculty members who were teaching courses about microcomputers at the Faculty of Education of the University of Toronto.

Survey of Parents

Class lists were obtained for fifteen randomly selected regular-program schools. Ten pupils were randomly selected from each school's list, and in mid January letters were sent to the parents or guardians of these pupils to explain the study and to ask them either to fill out a questionnaire about microcomputers or to be interviewed. (See appendix E.) Twenty-seven parents or guardians requested questionnaires, and four asked to be interviewed. (See appendix F.) Questionnaires were returned by fifteen parents in time to be used in the final coding. The parents or guardians requesting interviews were all interviewed in their homes at a time convenient to them.

Coding and Sorting

Substantive and theoretical coding of interviews, observations, and questionnaires was carried out according to the rules outlined by Glaser and Strauss (1967). Saturation of a substantive code was defined as being recorded ten times by one coder. Coding was performed by the observers, the research assistant, and the principal investigator.

Coding was conducted in three sessions, the first from December 13 to January 7, the second from February 14 to February 18, and the third from March 7 to March 31. Weekly meetings were held to discuss what questions could be asked in future to clarify the saturated codes already collected.

In early April the principal investigator and the project officer conducted a theoretical sort of the saturated substantive codes (see Glaser and Strauss 1967), classifying them in categories that were then used to derive the core category.

Appendix B: Survey Questionnaire Used in Part 1

THE BOARD OF EDUCATION FOR THE CITY OF TORONTO
155 College Street, Toronto M5T 1P6, Canada, 598-4931

September 22, 1982

To: Elementary School Principals

Re: Research Study on Microcomputers

The attached questionnaire is part of a research study the Board and the Ministry of Education are conducting of the impact of microcomputers in elementary education. It asks for a brief description of the microcomputers, if any, at your school, and for some information about how they are used.

Few systematic studies of this topic have been conducted, and the goal of the present study is to elaborate a theory which can be used to guide future applications in education. The information obtained from this questionnaire will be used both to develop this theory and to decide which schools to invite to participate in the second part of the study, in which research technicians will be interviewing staff and observing classes.

This questionnaire may be completed by yourself or some other staff member at your school who is involved in the use of microcomputers. It should take about half an hour to complete. If there are no microcomputers at your school, please return the blank questionnaire.

Questionnaires should be returned by October 8, 1982, to the Research Department. If you have any questions about completing the form, please call John FitzGerald at 598-4931, Ext. 392 or Sylvia Larter at Ext. 432.

Thank you for your help.

Sylvia Larter
SYLVIA LARTER, Ph.D.
Research Associate

John FitzGerald
JOHN FITZGERALD, M.A.
Research Assistant

SL:JF:vv
Encl.
cc: Director of Education
Associate Directors of Education
Area Superintendents
School Superintendents
Co-ordinator of Computer Studies and Applications
Chief Educational Research Officer

Edward N. McKeown, Director of Education/Ronald W. Halford, Associate Director of Education
Mitchell Lennox, Superintendent of Professional Services/Donald G. Rutledge, Superintendent of Curriculum & Program
Helen I. Sissons, Superintendent of Personnel/Michael J. Rose, Comptroller of Buildings and Plant/David S. Paton, Comptroller of Finance

School: ____

PART A - EQUIPMENT AND USERS

1. Please list below all the microcomputers now at your school on a long-term basis or that you expect to be at your school on a long-term basis this year (1982-1983).
Include in the list microcomputers lent by teachers or parents. Do not include peripheral equipment such as printers, disc drives, or cassette recorders.

Manufacturer (e.g. Commodore, Apple)	Model (e.g. 2001,4016,4032)	Number of Units
	Total	

2. How many of the microcomputers listed in #1 were purchased from Board funds other than the central budget for computer literacy and the furniture and equipment budget?
(Circle the appropriate number; if you don't know the number, check the box.)

0 1 2 3 4 5 6 7 8 or more ☐ Don't Know

3. How many of the microcomputers listed in #1 were purchased for the school out of funds other than Board Funds (e.g. Home and School Association Funds)?
(Circle the appropriate number; if you don't know the number, check the box.)

0 1 2 3 4 5 6 7 8 or more ☐ Don't Know

4. How many of the microcomputers listed in #1 were lent to the school by teachers?
(Circle the appropriate number; if you don't know the number, check the box.)

0 1 2 3 4 5 6 7 8 or more ☐ Don't Know

5. How many of the microcomputers listed in #1 have been given to the school by teachers?
(Circle the appropriate number; if you don't know the number, check the box.)

0 1 2 3 4 5 6 7 8 or more ☐ Don't Know

6. How many of the microcomputers listed in #1 have been lent to the school by parents?
(Circle the appropriate number; if you don't know the number, check the box.)

0 1 2 3 4 5 6 7 8 or more ☐ Don't Know

7. How many of the microcomputers listed in #1 have been given to the school by parents?
(Circle the appropriate number; if you don't know the number, check the box.)

0 1 2 3 4 5 6 7 8 or more ☐ Don't Know

8. Please list below all the peripheral equipment now at your school on a long-term basis or that you expect to be at your school on a long-term basis this year (1982-1983).
(Circle the appropriate number beside each item. If you do not have the equipment, circle 2, "Not in Use")

	In Use	Not In Use	Don't Know
Cassette recorder	1	2	3
Disc Drive	1	2	3
Printer	1	2	3
Game Paddles or joystick	1	2	3
TV monitor	1	2	3
Audio output (speaker)	1	2	3
Multi-user system (e.g. MUPET, Arbiter)	1	2	3
Other (please specify)	1	2	3

____

____

____

9. Has any of the equipment listed in #8 been lent to your school by teachers?
(Circle the number of the appropriate answer.)

1) Yes (please specify) ____________________
2) No
3) Don't Know

10. Has any of the equipment listed in #8 been given to your school by teachers?
(Circle the number of the appropriate answer.)

1) Yes (please specify) ____________________
2) No
3) Don't Know

11. Has any of the equipment listed in #8 been lent to your school by parents?
(Circle the number of the appropriate answer.)

1) Yes (please specify) ____________________
2) No
3) Don't Know

12. Has any of the equipment listed in #8 been given to your school by parents?

1) Yes (please specify) ____________________
2) No
3) Don't Know

PART B - USE OF MICROCOMPUTERS

1. When did your school obtain its first microcomputer?
(Circle the number in parentheses beside the appropriate answer.)

1977 (1)
1978 (2)
1979 (3)
1980 (4)
1981 (5)
1982 (6)
Don't Know (9)

2. Do you expect microcomputers to be used in special education at your school this year (1982 - 1983)?
(Circle the number of the appropriate answer.)

1) Yes
2) No
3) Can't Say

3. Do you expect microcomputers to be used for remedial instruction at your school this year (1982 - 1983)?

1) Yes
2) No
3) Can't Say

4. Do you expect microcomputers to be used for enrichment/advancement at your school this year (1982 - 1983)?

1) Yes
2) No
3) Can't Say

5. Which of the following statements do you expect will best describe students' use of microcomputers at your school this year?
(Circle the numbers of ALL appropriate answers.)

1) No students will use microcomputers.
2) A few students will use microcomputers occasionally.
3) Most students will use microcomputers occasionally.
4) A few students will use microcomputers regularly.
5) Most students will use microcomputers regularly.
6) Can't say.
7) Other description (please provide):

____

____

____

____

6. Which of the following statements do you expect will best describe teachers' use of microcomputers at your school this year (1982 - 1983)? (Circle the numbers of ALL appropriate answers.)

   1) No teachers will use microcomputers.
   2) A few teachers will use microcomputers occasionally.
   3) Most teachers will use microcomputers occasionally.
   4) A few teachers will use microcomputers regularly.
   5) Most teachers will use microcomputers regularly.
   6) Can't say.
   7) Other description (please provide).

____

____

____

____

7. Below are listed several methods by which microcomputers can be made available to staff and students. For each method, indicate how many microcomputers you expect to be made available by that method at your school during 1982-1983. (Put the numbers in the appropriate categories. If a microcomputer is used in more than one way, include it in all appropriate categories. If you cannot estimate, check the box marked "Uncertain".)

Method	**Number**
Kept in one classroom all or most of the time	______
Kept in the library all or most of the time	______
Kept in the office all or most of the time	______
Kept in the resource centre all or most of the time	______
Kept in the computer room or computer lab all or most of the time	______
Kept in a central place and taken to classrooms when needed	______
Other (please specify)	
____	______
____	______
____	______

☐ Uncertain

8. Do you expect that during the 1982-1983 school year regular formal meetings of students interested in microcomputers (that is, Computer Club meetings) will be held at your school? (Circle the number of the appropriate answer.)

   1) Yes
   2) No
   3) Don't Know

9. Do you expect that during the 1982-1983 school year occasional informal meetings of students interested in microcomputers will be held at your school?
(Circle the number of the appropriate answer.)

1) Yes
2) No
3) Don't Know

10. During the 1982-1983 school year, will a section of your library be devoted to books and periodicals dealing with computers?
(Circle the number of the appropriate answer.)

1) Yes
2) No
3) No library
4) Don't Know

11. Which of the following statements best expresses your expectations about the use of microcomputers during 1982-1983?
(Circle the number of the appropriate statement.)

1) The degree of microcomputer use at my school this year will be much greater than last year.

2) The degree of microcomputer use at my school this year will be somewhat greater than last year.

3) The degree of microcomputer use at my school this year will be about the same as last year.

4) The degree of microcomputer use at my school this year will be somewhat less than last year.

5) The degree of microcomputer use at my school this year will be much less than last year.

6) Can't say.

12. Microcomputers are used in many ways in schools today. Please describe briefly how your school uses microcomputers. We are particularly interested in innovative uses.

____

____

____

____

____

13. There is considerable controversy over the definitions of computer literacy and computer awareness. We would be interested to know how you define these two terms.

a) Computer literacy:

____

____

____

____

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13. b) Computer awareness:

14. Please list all teachers that you know are using microcomputers at your school. (You may prefer to attach a copy of the staff list with the appropriate teachers checked.)

	Teacher	Grade
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

15. Other comments about computer use in your school.

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THANK YOU FOR YOUR HELP.

173

Appendix C: Three Samples of Writing Done by Elementary Pupils With "Story Writer"

PUPET SHOW MAGIC

BY ERIN

oun day i was playing a pupet show for my frens then thay came to life i didit no what to do thay strtid to atac me then thay stapt thar finggrs and gost came thay chast me i ran owt the back door i went down the stret i sow a howse i went in it then i nottist i was in a hontid howse i trid to go owt the door but the gosts stopt me so i went up the staers then i sow a sine dracyls coffin i went in the room i sow a coffiin dracyl came owt i ran but i coudit ascap they ate me for diner

RUN

---

by MM+CR

CLOUD CITIES, FLYING HORSES BIKINI LADIES AND ME!

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

One early morning a little girl was walking in the meadow when she saw a big white object.So she went a little closer to see what it was to see what it was.Jill coulden't belive her eyes when she saw a beautiful white horse,but with wings!But then behind it was her old pal Philip! She ran up to him and gave him a big hug!Suddenly Philip turned into a frog and hopped away.She jumped on the horses back and the next thing she knew she was flying in the air.When they landed she was on sort-of like a city in the clouds.She got off and started to look around.When suddenly a little girl in a bikini jumped out at her and told her that if she didn't go back from where she came from the King would turn her into a bikini ladie too!Jill struggled as much as she could,but the gaurds wouldn't let go. She was suddenly stopped in front of a King. Jill didn't know what to do so she just bowed down in front of him and then he nodded back. He mumbuled someting to one of the ladies, then they all sat down. Then he said to her that she was going to become one of these ladies that he saw in front of her. then he started to give Jill a list of things that she would do. These are the things she had to do.

1. FAN HIM
2. BRING HIM FOOD
3. PAINT HIS NAILS
4. BRING HIM WATER

Then she saw that there were no guards at the gate so, she ran for it. Jill was much faster than the guards because they could not run in their heavy armour. She saw that there was a hole in the clouds and there was the horse that she came on! So she ran to it and hopped on it and it started to fly away. The next thing she knew she was at home, back at the place where the horse took off. Then out of the bush came

Philip! She was so glad to finally see someone that she knew!

He locked different!
She asked him if he knew about the cloud city and the flying horse.
He said that he did .Jill asked him to explain it to her.Philp told her that he found the horse 5 years ago hidden in a bush.He got on it and it went to a flying city.When he got out he saw guards all around him.There was a king that told him that the reason he had brought him to this land is because that they needed a new queen for there city.But I'm not a girl!How can I be a queen if I'm not a girl! The king told me that he had been watching me and he knew that I had a girl-friend,you!Oh I'm asking you to marry me so we can go up to the city in the clouds.So I'm waiting for an answer Of corse I'd love too!
Good then we will go tomorrow!

So the next day they went to the cloud

city and became the King and Queen of the city and lived happily ever after.

STORY

-----

by GUS K.

/**CITY PULSE NEWS**/

/*******************/

Mrs.Hood sent her daughter to her grandmother,with some cookies.Mrs. Hood told her not to talk to strangers,but she did and he almost got her and took her.But she got away and then she got to her grandmother,she lifted the cover and it was the wolf,her grandmother was outside looking for help and sHe found an ax men,and he killed the wolf.

```
/-----------------------/
/ +++++++  +   +  +++++ /
/    +     +   +  +     /
/    +     +++++  ++++  /
/    +     +   +  +     /
/    +     +   +  +++++ /
/                       /
/  +++++  +   +   ++++  /
/  +      ++  +   +   + /
/  ++++   + + +   +   + /
/  +      +  ++   +   + /
/  +++++  +   +   ++++  /
/////////////////////////
```

Appendix D: Excerpt From the Report Written by Sandra Browne Entitled "Toronto Board of Education LOGO Field Study Report"

Mechanics of Computer Usage

As is true of most introductions to computers, insufficient attention was paid to the mechanical problems associated with using the computer. This was, however, not a major problem as some of the children in the classroom had computers at home on which they wrote their own programs. One student played a major role in assisting work in this area and another played a minor role. When this type of assistance was insufficient and the children could not figure out what to do, the consultants who were designing this course were asked to come in to provide assistance.

Initially familiarity with the keyboard and with special purpose keys was all that was required. In spite of the fact that each child was given material explaining the required keyboard usage, none of them read the material they were given. They had to be given a demonstration of how to use the keyboard.

In fact, throughout this experiment the general desire to have expert explanation of all mechanical features was absolute. No matter how clear the written explanations provided by the manual or by the programs run on the computer, they were unsure of what should be done until they had been given a live demonstration.

After the mechanics of the keyboard and the elementary instructions required to get the turtle to draw pictures had been mastered, a tape unit was introduced to allow the children to save and to show the work which they had done.

Initially this was done by having the two experienced children enter the work which was written on the observation sheets and save the procedures created in this way on a tape. An attempt was made to have the children [illegible] the work they did on the computer as they did it. This attempt was unsuccessful because of the cumbersome mechanics of saving and of recalling material from a tape.

In January Texas Instruments made a disk drive available for use in this field trial [1]. This disk drive made it possible to accomplish significantly more on the computer as each child could save the work which she had done.

The preliminary phase where easy storage of work was not possible was extremely valuable inasmuch as it emphasized the importance of accurate observation and recording skills. Continued dependence upon such techniques, however, would have limited the complexity of the work which could have been done by limiting the child's ability to build on material which had been created during previous sessions.

When the disk was first added to the computer, no explanation was given on how to use it because the only mechanical skill required to use a disk drive is the ability to put the disk into the drive right way up and to close the door, an operation with which one of the children was already familiar.

6

The instructions for how to save or to recall material from the disk are step by step instructions given on the screen as a set of questions. These instructions are simple enough that they could easily be used to instruct a machine. Nonetheless, without an expert demonstration of how the disk should be used, neither the children, the teacher, nor an adult observer could understand how to use the disk.

This apparent inability or absolute refusal to learn from written material should constitute a thought provoking reflection on the methods which children are encouraged to use to learn new skills. methods which children are encouraged to use to learn new skills. More practically, it poses a problem in trying to create programs for rapid dissemination over a wide area where expert assistance is not always available.

NOTES

[1] The consultants would like to acknowledge the kind assistance of Mr Tony Donevsky of Texas Instruments in obtaining a disk drive which could be used during this field study.

Work Sheet Design

The format used for the work sheets which were developed was based on some of the work done by Dr Floyd Robinson. Dr Robinson has written treatises on teaching thinking in a number of curriculum areas and, with co-workers, has worked particularly intensively in this area in the O.I.S.E. Niagara Regional Office.

In the work done by Dr Robinson and his co-workers in all areas there is a common theme with regard to the presentation of material. The approach is designed to provide familiarity with tools of thought as well as with the subject material at hand, and is best summarised in the Appendix of "Teaching a Model for Experiments" [1]. The basic steps of scientific investigation defined in this treatise are:

- State the problem as a question
- Clarify and reword the question
- Make a plan for answering the revised question
- Carry out the plan
- Record the data obtained to show relationships
- State relationships observed
- Interpret the relationships

All of the sheets prepared for this field trial were based on this set of steps. Initially each of the work sheets given to the students was designed to encourage the accomplishment of one or more of the above phases of experimental development.

The concept was that by embedding this methodology in the computer sheets, the children would be introduced to an effective approach to problem solving which could be used with all types of problems.

The sheets which were given to the children at first were:

- A Problem Sheet to state the problem and the session objectives and to introduce the major principles and references which would be required to complete the work.

- A Planning Sheet to assist in the clarification and the rewording of the question and to allow the children to make a plan to be carried out in the computer session.

- An Observation Sheet to record what happened when the plan of action was carried out

- A Log Sheet to encourage the children to formulate and to interpret the relationships observed during the computer session.

8

The first unexpected difficulty which was encountered was that the children seemed to find so many sheets of paper completely bewildering. They could not sort out what they should be doing on which sheet, even when the sequence of operations was discussed and illustrated with reference to each type of sheet.

Upon reflection, this should not have been entirely surprising as they were given a total of eight pieces of paper some of which were stapled together; none of which were numbered.

Generally it was found that item and page numbering were extremely important in helping to keep the material organized; subsequently, sheets such as the Observation Sheet were kept for distribution when the children were ready to sit down at the computer.

The first Problem Sheet given to the children is shown on the next page.

It was felt that the references were of particular importance because the manuals would provide experience in learning to do by reading. The references to their mathematics books were supposed to help them relate their computer work to their normal math work.

In fact what happened was that as this first Problem Sheet contained no questions so that nothing demonstrable had to be done with it, it was completely ignored. Subsequently, when basic concepts were introduced on the problem sheets, a series of questions such as those shown on Problem Sheet 3 were given to ensure that the children actually looked at the material.

9

PROBLEM SHEET 1

Getting to Know You

PROBLEM - Become familiar with the mechanics of using the computer by

getting LOGO into and out of memory
learning how to interpret error messages
learning how to correct typing mistakes
learning how to use the computer as a calculator

HINTS - If you type	What happens?
3 + 4 (press ENTER)	The computer says, "TELL ME WHAT TO DO WITH 7". Discussion of this on Manual pages 6, 63-64
PRINT 3 + 4	Computer prints "7"
PIRNT 3 + 4	Computer types, "TELL ME HOW TO PIRNT" See manual page 6.

The math book references are given to help you find examples of problems to get the computer to do.

USEFUL REFERENCES

TI LOGO Manual , pages	vi - vii
	6
	1 - 4
	63 - 64
Grade 6 Math Book, pages	18 - 33
	52 - 75
	10 - 11
Grade 5 Math Book, pages	17 - 23
	28 - 35, 38 - 39
	44 - 61
	80 - 97
	194 - 207
	10 - 11

10

NAME________________________________

Page 1

PROBLEM SHEET 3

Drawing with Turtles?

PROBLEM - Get the Turtle to draw the equilateral shape of a
triangle
square
pentagon
hexagon

QUESTIONS

1. Read the material you have been given from the LOGO manual to find out how to get the turtle to draw pictures for you.
2. What command would you type to get the turtle to move forward 50?
3. What command would you use to get the turtle to turn?
4. What does equilateral mean? (You will probably have to look in the dictionary).
5. What does tri- mean? (Dictionary)
6. How many sides are there in a triangle?
7. How many angles (vertices) are there in a triangle?
8. In order for the turtle to make an equilateral shape it has to turn through all of the directions of the compass one complete time. This is called a Total Turtle Trip. There are 360° in a Total Turtle Trip.
9. REPEAT 3 [RIGHT 120 FORWARD 30] will make the turtle draw a triangle.
10. How many times will the turtle have to turn right?
11. How many degrees will the turtle turn each time it turns?
12. What is the total number of degrees he will turn through?
13. Can you see any relationship between the number of sides and the number of turns and the number following REPEAT?
14. How do you clear the screen so you are ready to draw something else?

The second set of sheets which the children were given were initially entitled Planning Sheets. Later these sheets were called Work Sheets. The change in terminology was unwarranted and it would have been best to maintain the original name of Planning Sheet.

Where a specific set of activities, such as drawing regular polygons, were to be carried out, the left half of these sheets was left blank. The title for this column was "Type". The right half of the sheet gave instructions of what was to happen on the computer. The children had to write what they would type on the computer on these sheets before they were allowed to use the computer.

A sample of this type of sheet is given on the next page.

There were several deliberate points of parallelism between the Problem Sheet shown on the previous page and on the Work Sheet shown on the following page.

The LOGO instruction set for drawing an equilateral triangle can be copied from the Problem Sheet to the Work Sheet. The instruction set for drawing a square are given on the Work Sheet itself. All of the instruction sets are given using the REPEAT command. The questions on the Problem Sheet are designed to emphasize the repetitive actions involved in drawing an equilateral figure.

This interweaving of material appeared to work extremely effectively. Later in writing LOGO procedures, several of the children used the REPEAT command effectively with no "formal" instruction on REPEAT. This technique for conveying REPEAT has the advantage of short circuiting the time required to have children type the same thing over and over again until they discover that REPEAT can save significant amounts of typing time and effort.

Before this material was given to the Grade 5/6 children involved in this field study, three grade seven children worked through it. At the time, these children were using computers as part of an intensive introductory computer literacy program offered by the Toronto Board. Their comment was that the questioning and the repetition made it much easier to learn and to understand what they were learning than it was with the sheets they were using with their computer literacy course.

The literacy course material told them what to type when they were on the computer, but apparently little explanation of what was happening was given. The result, the children said, was that it was possible to faultlessly execute all of the material covered on three pages and still have no idea what you were doing or what you were supposed to be learning.

NAME ______________________________ Page 3

WORK SHEET 3

Drawing with a Turtle?

Type	To Do
	1. Set the turtle to draw a line of length 100
	2. Take the turtle back to the starting position
	3. Turn the turtle to face East
	4. Turn the turtle to face South
	5. Turn the turtle to face West
	6. Draw another line of length 100
	7. Clear the screen
	8. Draw an equilateral triangle
REPEAT 4 [RT (360/4) FD 30]	9. Draw a square
	10. Draw an equilateral pentagon
	11. Draw an equilateral hexagon

The Observation Sheet was the next sheet in the series. This was used by the children only during computer usage sessions. As all of these work sheets were written using a word processor, preparation of this sheet was accomplished by double spacing the material on the Problem Sheet and switching the order of the columns.

The exact replication was deliberate. On the Planning (Work) Sheet the "To Do" column was to guide them in deciding what instructions should be written down. On the Observation Sheet the "To Do" column was repeated to emphasize that there was an objective in terms of what should be done or seen on the screen.

One of the most frustrating problems encountered with children who are learning to program is trying to get them to explain what they are doing. Any such question is usually answered with spoken programming commands such as "RIGHT 50", rather than with a statement of the purpose behind the issuance of such commands. Not only does this lead to some singularly frustrating and unenlightening conversations, it also traps the child in a mental set which often makes it impossible to solve problems which are encountered.

Only when the child can step back and review the activity which is being attempted can she look at the programming commands which she is using to see if they are appropriate and efficient.

The emphasis on the purpose of carrying out certain commands was designed to try to counteract this tendency.

The OT and CA notations shown on the following Observation Sheet is one which was created by one of the teams. Generally the children found it difficult to record what was happening at the computer. OT for Operator Typed, and CA for Computer Answered helped them organize their observations by providing convenient labels.

NAME ____________________________ Page 4

OBSERVATION SHEET 3

Drawing with a Turtle?

To Do	OPERATOR TYPED/ COMPUTER ANSWERED
1. Get the turtle to draw a line Of length 100 100	1. OT CA
2. Take the turtle back to the starting position	2. OT CA
3. Turn the turtle to face East	3. OT CA
4. Turn the turtle to face South	4. OT CA
5. Turn the turtle to face West	5. OT CA
6. Draw another line of length 100	6. OT CA
7. Clear the screen	7. OT CA

15

The final work sheet in the series was the Log Sheet. In many ways the concept behind this sheet was of more critical importance than that behind any of the other sheets.

Whenever one learns something by trial and error, the final cementing of that knowledge into one's total body of knowledge is best accomplished by reviewing what was done so that successful experimental actions can be stated as abstract principles.

If an ice skater does something on the ice which he really likes, he may say, "Hey, that was neat. How did I do that?" The Log Sheet was designed to try to get the children to ask "How did I do that?" with reference to the work which they did on the preceding work sheets.

The attainment of this objective was difficult. It was difficult to develop questions which would point to the general principles involved in the lessons. More importantly, however, it was too difficult for the children to see any reason for the existence of this sheet. There were no obvious right and wrong answers, and they seldom even answered the questions.

After four weeks the log sheets were eliminated and an attempt was made to cover this material in classroom discusssions at the end of the week. Children are seldom asked to experiment to solve problems and then to review what they have done to see what they have done right. The concept behind the Log Sheets may have been too alien to them.

If that was the case, it would be interesting if another field trial initially emphasized this review in classroom discussions and worked towards the gradual introduction of the Log Sheets.

Another type of work sheet which was initially developed and subsequently abandoned was an Extra Problem Sheet. This sheet was designed to be used by the children who were able to complete the initial material quickly. This sheet was abandoned because once the initial material had been completed, the children were not given any time to make further use of the computer.

The important thing about these sheets is not what they are. The important thing is that they were developed to encourage preparatory desk work and to introduce programming and a formal problem solving technique. They fulfilled these purposes well.

As they were developed using a formal methodology, anyone who was interested could develop their own set of sheets in any subject. Samples of all of the sheets which were used in this field trial are given in the Appendix of this report. An expanded discussion of how this technique could be used in other subject areas is given in the Summary and Recommendations section.

16

Mrs Laski, the classroom teacher, has summarized her experience in using this format to present material by saying that the preparatory work was absolutely essential to productive work. The primary difficulty was that the amount of work required was enough that many children had difficulty in accomplishing all of it so that they could use the computer. This meant that even though technical expertise was not required of her, she had to do a great deal of administrative work to ensure that the children had adequately prepared for their computer session.

The children's attitude toward the computer was informative. A few children were completely infatuated with the experience, and a few were totally indifferent to negative towards it. Most of them enjoyed working on the computer and resented any occasional teacher who insisted on lecturing them rather than letting them get on with their computer work. The generally positive attitude toward the computer was not, however, unconditional. At one point the children felt that too much desk work was required and they commented that if they had to do all that work to use the computer, they would rather skip the whole thing.

NOTES

[1] D. Storey and F. Robinson,
"Teaching a Model for Experimentation",
Informal Paper, Northeastern Centre, Ontario Institute for Studies in Education, 1974.

Appendix E: Parent Letter and Consent Form

THE BOARD OF EDUCATION FOR THE CITY OF TORONTO
155 College Street, Toronto M5T 1P6, Canada, 598-4931

January 3, 1983

Dear Parent/Guardian:

The Toronto Board of Education, in cooperation with the Ministry of Education, is conducting a study of the effects of microcomputers in elementary education. Research technicians are now visiting schools to observe the use of microcomputers and to talk to students and teachers about them.

We would also like to know what parents and guardians think about microcomputers in the schools. Over the next few years, important decisions about the use of microcomputers will be made, not only by the Toronto Board, but also by school boards throughout the province. Any help you can give us will enable boards of education throughout Ontario to make these decisions more wisely.

If you would like to help us during January or February, please return the enclosed white form, indicating how you would like to be involved (the pink copy is for your records).

Your name will not appear in any report, nor will names be retained in our files. If you have any questions, please call John FitzGerald at 598-4931, ext. 392.

Thank you for any help you can give us.

Yours sincerely,

Sylvia Larter
Sylvia Larter
Research Associate

John FitzGerald
John FitzGerald
Project Officer

Edward N. McKeown, Director of Education/Ronald W. Halford, Associate Director of Education - Operations
Donald G. Rutledge, Associate Director of Education - Program/Charles W. Taylor, Superintendent of Curriculum and Program
Helen I. Sissons, Superintendent of Personnel/Michael J. Rose, Comptroller of Buildings and Plant/David S. Paton, Comptroller of Finance

MICROCOMPUTER STUDY

PARTICIPATION FORM

Please check the appropriate box and provide the information required.

☐ I would like to complete a questionnaire.

Name ______________________________

Address ______________________________

____

In what language should your questionnaire be written?

____

☐ I would like to be interviewed BY TELEPHONE.

Name ______________________________

Telephone ______________________________

In what language would you like to be interviewed?

____

☐ I would like to be interviewed AT HOME.

Name ______________________________

Telephone ______________________________

In what language would you like to be interviewed?

____

☐ I do not wish to be interviewed or to complete a questionnaire, but would like to make a few comments. (If the space below is not sufficient, please feel free to continue on another sheet, or sheets.)

ALL INFORMATION YOU PROVIDE WILL BE KEPT STRICTLY CONFIDENTIAL

Appendix F: Parent Questionnaire

THE BOARD OF EDUCATION FOR THE CITY OF TORONTO
155 College Street, Toronto M5T 1P6, Canada, 598-4931

February 1, 1983

Dear Parent/Guardian:

Thank you for volunteering to take part in our study of the effects of microcomputers in elementary education. Enclosed is a copy of the questionnaire you requested. We would appreciate if you could complete it as quickly as possible and return it in the envelope provided.

If you have any questions about the content of the questionnaire, please call John FitzGerald at 598-4931, ext. 432.

Again, thank you for your help.

Yours sincerely,

Sylvia Larter　　John FitzGerald

Sylvia Larter
Research Associate

John FitzGerald
Project Officer

Encl.

dm

Edward N. McKeown, Director of Education/Ronald W. Halford, Associate Director of Education - Operations
Donald G. Rutledge, Associate Director of Education - Program/Charles W. Taylor, Superintendent of Curriculum and Program
Helen I. Sissons, Superintendent of Personnel/Michael J. Rose, Comptroller of Buildings and Plant/David S. Paton, Comptroller of Finance

SURVEY OF PARENTS

Microcomputers are small computers commonly known as home computers. They are being used in almost every elementary school in Toronto. We would like to know what you and other Toronto parents think about the use of such computers in the schools.

NOTE: In the following questions, the term "elementary school" refers to any school offering any grades below grade 9.

A. HOME USE OF MICROCOMPUTERS

1. Do you have a microcomputer at home?

yes ☐
no ☐

(If you answered NO to question 1, please continue with question 5.
If you answered YES to question 1, please continue with question 2.)

2. About how many hours a week does your child spend using your microcomputer? _____

3. What does your child use your microcomputer for?

____
____
____
____

4. What do you use your microcomputer for?

____
____
____
____

(If you have answered questions 2 through 4, please continue with question 6.)

5. Are you planning to buy a microcomputer within the next year?

no ☐
yes ☐ If you answered 'yes', for what purposes will you use it?

____
____
____

6. Can you program in any computer languages?

no ☐
yes ☐ Which languages? ____________________

____
____
____

7. Does your work require you to program in any computer language?

no ☐

yes ☐

8. Does your work require you to use a word processor?

no ☐

yes ☐

9. How important do you think it is for adults to learn computer programming?

very important ☐

somewhat important ☐

of little importance ☐

unimportant ☐

can't say ☐

10. Is your child now using a microcomputer at school?

no ☐

yes ☐

can't say ☐

(If you answered YES to question 10, please continue with question 12. If you answered NO, or CAN'T SAY, please continue with question 11.)

11. Would you like your child to use a microcomputer at school?

no ☐

yes ☐

can't say ☐

12. Do you have any additional comments about questions 1 to 11?

____

____

____

____

____

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B. GENERAL QUESTIONS ABOUT THE EDUCATIONAL USE OF MICROCOMPUTERS

13. What do you think are the most EFFECTIVE ways that microcomputers could be used in elementary schools?

14. Is there anything that you think schools SHOULD be doing with microcomputers that they are NOT doing now?

15. Is there anything that elementary schools are doing with microcomputers that you consider especially valuable?

16. Is there anything the schools are doing with microcomputers that you think they should NOT be doing?

17. Do you have any additional comments about questions 13 to 16?

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B. GENERAL QUESTIONS ABOUT THE EDUCATIONAL USE OF MICROCOMPUTERS

13. What do you think are the most EFFECTIVE ways that microcomputers could be used in elementary schools?

14. Is there anything that you think schools SHOULD be doing with microcomputers that they are NOT doing now?

15. Is there anything that elementary schools are doing with microcomputers that you consider especially valuable?

16. Is there anything the schools are doing with microcomputers that you think they should NOT be doing?

17. Do you have any additional comments about questions 13 to 16?

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C. THE USE OF MICROCOMPUTERS IN SCHOOL

18. How would you rate the use of microcomputers at your child's school?

very poor ☐
poor ☐
fair ☐
good ☐
very good ☐
can't say ☐

19. Is your child learning computer programming in school?

no ☐
yes ☐
can't say ☐

(If you answered YES to question 19, please continue with question 21.
If you gave another answer, please continue with question 20.)

20. Would you like your child to learn computer programming in school?

no ☐
yes ☐
can't say ☐

21. How important do you think it is that children learn computer programming in elementary school?

very important ☐
somewhat important ☐
of little importance ☐
unimportant ☐
can't say ☐

22. Is your child acquiring in school an understanding of the uses of computers throughout society?

no ☐
yes ☐
don't know ☐

(If you answered YES to question 22, please continue with question 24.
If you gave another answer, please continue with question 23.)

23. Would you like your child to acquire in school an understanding of the uses of computers throughout society?

no ☐
yes ☐
can't say ☐

24. How important do you think it is that children acquire in elementary school an understanding of the uses of computers throughout society?

very important ☐
somewhat important ☐
of little importance ☐
unimportant ☐
can't say ☐

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25. Do you think that elementary schools should provide a separate course in computers?

no ☐

yes ☐

can't say ☐

If you answered YES, please describe the topics you think such a course should cover.

____

____

____

____

____

____

26. At what age do you think children should start to use microcomputers in school? _____

27. Do you foresee any special problems arising in the use of microcomputers in the schools?

____

____

____

____

____

____

28. Do you have any other comments about questions 18 to 27?

____

____

____

____

____

____

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D. INVOLVEMENT OF PARENTS

29. Do you think parents should be actively involved in providing your child's school with computer equipment, materials, or expertise?

no ☐
yes ☐
can't say

If you answered YES, please elaborate.

30. Have you ever talked to school staff about the use of microcomputers in the schools?

no ☐
yes ☐

If you answered YES, please elaborate.

31. Do you have any other comments or suggestions?

THANK YOU FOR YOUR HELP.

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